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PREPARATORY SURVEY FOR METRO MANILA SEWERAGE AND SANITATION IMPROVEMENT PROJECT- PHASE-2

FINAL REPORT

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MEASUREMENT UNITS

Length

mm	-	millimeter
cm	-	centimeter
m	-	meter
km	-	kilometer

Time

s, sec	-	second
min	-	minute
hr	-	hour
dy	-	day
mon	-	month
yr	-	year

Area

sq m	-	square meter
sq km	-	square kilometer
ha	-	hectare

Volume

cum	-	cubic meter
l, ltr	-	liter
mcm	-	million cubic meter

Weight

g, gr	-	gram
kg	-	kilogram
t	-	ton

Speed

cm/s	-	centimeter per second
m/s	-	meter per second
km/h	-	kilometer per hour

ABBREVIATIONS

ADB	Asian Development Bank
amsl	above mean sea level
BIR	Bureau of Internal Revenue
BDT	Bureau of Domestic Trade
BOD	Biological Oxygen Demand
BOT	Build-Operate-Transfer (mode of project delivery)
BSWM	Bureau of Soil and Water Management
CA	Concession Agreement
CAS	Conventional Activated Sludge
CARP	Comprehensive Agrarian Reform Program
CBR	Crude Birth Rate
CDM	Clean Development Mechanism
CDR	Crude death rate
CEF	Carbon Emission Factor
CER	Certified Emission Reduction
CG	Coastal Guard
CO	Carbon Monoxide
CO_2 -	Carbon Dioxide
CWA	Clean Water Act
DA	Department of Agriculture
DAO	DENR Administrative Order
DAR	Department of Agrarian Reform
DCCD	DCCD Engineering Corporation
DENR	Department of Environment and Natural Resources
DepEd	Department of Education
DOLE	Department of Labour and Employment
DOE	Department of Energy
DOH	Department of Health
DPWH	Department of Public Works and Highways
ECC	Environmental Compliance Certificate
EGF	Environmental Guarantee Fund
EIRR	Economic Internal Rate Return
EIS	Environmental Impact Statement
EMB	Environmental Management Bureau

EMF	Environmental Monitoring Fund
ER	Emission Reduction
ERU	Emission Reduction Unit
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
HCPTI	Harbour Centre Port Terminal Inc.
HLURB	Housing and Land Use Regulatory Board
ICP	International Competitive Bidding
IEC	Information Education and Communication
IEE	Initial Environmental Examination
IMR	Infant Mortality Rate
IET	International emissions trading under the Kyoto Protocol
IRA	Internal Revenue allotment
IRR	Implementing Rules and Regulations
JICA	Japan International Cooperation Agency
JI	Joint Implementation
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority
MG	Municipal Government
MIAA	Manila International Airport Authority
MICT	Manila International Container Terminal
MMDA	Metro Manila Development Authority
MMR	Maternal Mortality Rate
MMT	Multi-partite Monitoring Team
MWCI	Manila Water Company, Inc.
MWSI	Maynilad Water Services Inc.
MWSS	Metropolitan Waterworks and Sewerage System
NAIA	Ninoy Aquino International Airport
NCR	National Capital Region
NESSS	National Emission Standards for Source Specific Air Pollutants
NO_{2} -	Nitrogen Dioxide
NPCC	National Pollution Control Commission
NSO	National Statistics Office
NWRB	National Water Resources Board

OEC	Original Engineering Consultants Co., Ltd.
POx	Photochemical Oxidant
PFZ	Philippine Fault Zone
PDD	Project Design Document
PHIVOL	Philippine Institute of Volcanology and Seismology
PMB	Philippine Mobile Belt
PTMO	Parañaque Traffic Management Office
PRRC	Pasig River Rehabilitation Commission
RA	Republic Act
SEC	Securities and Exchange Commission
SpTP	Septage Treatment Plants
STP	Sewage Treatment Sludge
SW	Shopping for Works
UNFCCC	United Nations Framework Convention on Climate Change
VFS	Valley Fault System
VS	Volatile Solids

8 RECOMMENDABLE PROGRAMS OF SEWERAGE AND SANITATION IMPLEMENTATION PLAN

This Section discusses the need for sewerage and sanitation improvement project on the basis of the appreciation of the status or conditions of the Project target areas, the estimates of the pollution load and hygienic concerns in the project areas and the need to implement the sewerage and sanitation plan to address the critical environmental conditions. The need for a Japanese technical grant is recognized.

The project alternatives consisting of 8 cases are described that cover the organization of sewage treatment plants, the applicable sewage treatment process to each site candidates and their comparisons, and the applicable sewage sludge treatment process. The project scope, breakdown of project cost estimates and implementation plan are presented for each of the cases. Selection criteria were formulated and the case that got the highest rating was recommended. Conceptual designs covering technical specifications, design drawings and least cost study of project facility construction are presented.

8.1 Needs for Sewerage and Sanitation Improvement Project

8.1.1 Project Target Area Status in Metro Manila

The project target areas for Preparatory Survey Phase 2 are located almost in the central area of Metro Manila, where as much as 12 million people are residing and composing lots of congestion areas. Almost all of the wastewater generated in the households is discharged into receiving bodies without any treatment. Manila Bay, Pasig River and its tributaries, and Laguna Lake are the main receiving bodies of the wastewater. Parañaque River, Las Piñas River, and creeks in Cavite Province are main conveyors of water and wastewater discharging into Manila Bay. However, these catchment areas including Manila Bay are main supply sources of food, life conveniences, employments and recreations to about 23 million people living in these catchment areas. GDP of these areas represents 55% of whole Philippine GDP and gross production rate of agricultural, fishery and forest industries reach at 55% of country total.

However, the environmental infrastructures, such as wastewater management, sewage treatment system, solid waste management, and sludge management, which are essential to support socio-economical and industrial development and sustainability of them, have been greatly damaged, and not keeping in step with the general advances of urbanization and industrialization for sustained economic development.

As such, the growth of Metro Manila, which consists of first-class cities in the Philippines, has brought about various negative impacts on the city and its people. Increasing traffic congestion, worsening environmental conditions, and decreasing accessibility to needed services have become more prevalent in the past years. Without comprehensive and integrated countermeasures, living conditions will further worsen, the cities' competitiveness in the region will decrease, the environment deteriorates, and the cities' image becomes spoiled.

8.1.2 Pollution Load and Hygienic Concerns in Project Areas

The population of the target area of Parañaque and Las Piñas was approximately 1.1 million in 2007, and is expected to rise to approximately 1.4 million by the target year of 2036. The sanitary sewage from this population flows daily into Manila Bay. The WHO has set a figure of 45 g/person/day as the appropriate base unit of pollutant load in tropical areas, and the same figure shall be adopted here. **Table 8-1-1** shows the generated pollutant load at present and in the future based on this base unit. The generated pollutant load in 2036 will be 62.7 t/d, which is 1.28 times higher than the value in 2007, meaning that the pollution of creeks and Manila Bay will deteriorate even further if the sewerage system does not undergo further development.

Since the sewage system will play a major role in securing public hygiene, improving the living environment and stopping water pollution in Manila Bay, it will be necessary to quickly build the system in Parañaque and Las Piñas. **Table 8-1-2** and **Figure 8-1-1** show the pollutant load and graph in the case where the sewage system is constructed in Parañaque and Las Piñas. As is shown in **Figure 8-1-1**, the pollutant load at the end of inflowing stream in the case of sewage system construction will be greatly reduced by 36 percent in 2016, 50 percent in 2021, 63 percent in 2026, 76 percent in 2031 and 90 percent in 2036.

Table 8-1-1 Yearly Generated Pollutant Load

Name		2007	2011	2016	2021	2026	2031	2036
Paranaque	Population	557,857	592,440	633,857	669,860	700,130	724,263	740,871
	Pollutant Load(kg/d)	25104	26660	28524	30144	31506	32592	33339
Las Pinas	Population	535,208	562,490	591,540	615,070	633,127	645,662	652,737
	Pollutant Load(kg/d)	24084	25312	26619	27678	28491	29055	29373
Total	Population	1,093,065	1,154,930	1,225,397	1,284,930	1,333,257	1,369,925	1,393,608
	Pollutant Load(kg/d)	49188	51972	55143	57822	59997	61647	62712

Table 8-1-2 Pollutant Load in Case of Sewage System Construction Unit: (kg/d)

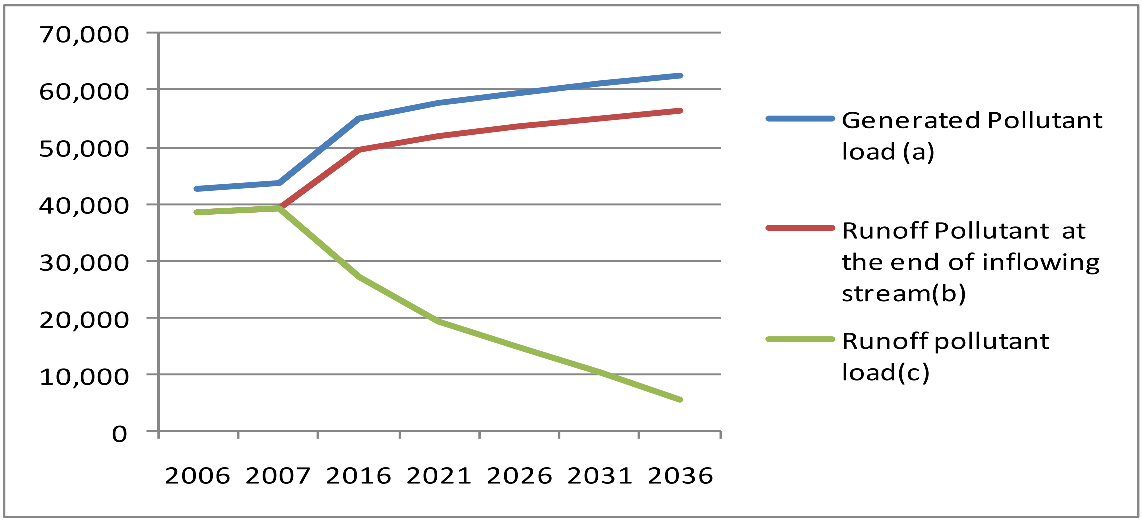
	2007	2011	2016	2021	2026	2031	2036
Generated Pollutant load(a) kg/d	49,188	51,972	55,143	57,822	59,997	61,647	62,712
Run off Pollutant at the end of inflowing stream(b) kg/d	44269	46775	49629	52040	53997	55482	56441
Run off Pollutant load	44,269	46,775	31,762	26,280	19,979	13,038	5,644

The pollutant runoff coefficient at the end of inflowing stream, which is used in calculating the

pollutant load at the end of inflowing stream, expresses the degree of reduction in generated pollutant load resulting from sedimentation after it flows into streams and creeks (rivers) and arrives at the treatment plant (water quality measuring point). Since there is a lot of intercepted sewage from the combined sewers in this case, the pollutant runoff coefficient at the end of inflowing stream has been set at 0.9.

Runoff load has been calculated upon assuming the sewage system construction rate to be 40 percent in 2016 and 100 percent in 2036 and the removal rate in treatment plants to be 90 percent.

Figure 8-1-1 Projected Effects in Case of Sewage System Construction



A correlation exists between construction of city water and sewerage facilities and the generation rate of water borne infectious diseases. In the event where sewage system development is not carried out, potential impacts will be pollution of the public water body, generation of odor, and outbreaks of infectious diseases caused by people coming into contact with polluted water.

Most water borne infections are contagious. Bacteria originating in animal or human excreta, viruses, wild animals and parasites are consumed with food and water, or they enter the body orally via hands and fingers. Many pathogenic organisms that enter the body propagate in the intestines and are discharged from the body once again together with excreta. Therefore, unless appropriate sanitary countermeasures are taken, associated water bodies become infected and numerous people are placed at risk of infection. Water borne diseases are classified in the manner shown below.

● Orally infected diseases

Typical examples are cholera and typhus, etc. These arise from water borne infections caused by the excreta of humans and animals that have been infected by pathogens (bacteria and viruses). Unless a hygienic water supply system and environmental sanitation facilities are installed, these kinds of water borne diseases are spread through ingestion of water.

● Diseases caused by use of unsanitary water

Contagious skin infections and eye aliments, etc. are caused by washing or bathing in unsanitary water.

● Diseases caused by contact with contaminated water

These diseases are caused by parasites (hematozoons and diatoms, etc.) that use aquatic wildlife species as intermediary hosts.

● Diseases caused by insects

These diseases are caused by insects that live and propagate around water bodies (for example, malaria, filarial, dengue fever and yellow fever, etc. carried by mosquitoes).

Occurrence rates and fatality rates linked to these diseases can be reduced through conducting the appropriate separation and treatment of night soil.

For Parañaque and Las Piñas cities, sewerage coverage was not made in the MWSI business plan of 2007, and in the revised business plan of 2008 which indicate sewerage service coverage in their whole business area of 43% to 66%. Only about 28,000(about 2% converge) people in total of both Parañaque and Las Piñas Cities in total out of whole residents in Parañaque and Las Piñas are planned to be covered in the revised sewerage service business plan.

Actually to say, by non-integrated construction of the drainage system, poor collection system, inappropriate site and gradient of the system, poor operation and maintenance, lack of control and treatment of wastewater, and many sites in the cities are frequently flooded during the rainy season, are adversely affecting the lives and health of people in the community.

In order to evaluate the surface water conditions, water sampling and quality analysis were conducted at 28 sampling points of the rivers and creeks in Parañaque and Las Piñas Cities on 29-30 July 2010. The results show that total coliform level reaches at $23x10^5$～$92x10^6$ MPN/100ml, BOD_5 level reaches at 13～46 mg/L, against DENR standards of total coliform:5,000 MPM/100ml, and BOD_5: 7mg/L. These polluted levels are surely impacting seriously to the areas. Actually, by the records of DOHs of the two cities reveal that water borne diseases in the areas run over 20,000 people and 10,000 people died because of the diseases.（by DOHs of the city governments, 2009） These facts indicate the need to start urgent projects to improve environmental situation.

8.1.3 Needs of Implementing Sewerage and Sanitation Systems

In order to address and resolve these crucial environmental conditions, this preparatory study including the feasible study of sewerage system implementation is required to develop the sewerage service coverage in the project areas as much as possible reaching to whole project areas; taking into consideration MWSS plan to cover almost 100% people by sewerage by 2036.

The project investments would be mainly concentrated on establishing sewage treatment systems in the target areas with key performance indicators of (a) a reduction in the number of days of properties and businesses suffer flooding; (b) a reduction in the incidence of water-related and vector-bone diseases (diarrhea, dysentery, cholera, typhoid, malaria etc); (c) increased income arising from tourism in the project areas (more tourists visiting and more nights spent per tourist), and (d) increased external investment (new businesses locating and expansion of existing businesses) in the cities as a result of the more attractive environment.

And also it would be expected to cater for hygiene improvement of poor families by introducing flush toilet (without filter tanks) superseding existing pit latrines. The sepatage from the septic tank would be pumped periodically by special vehicles of Maynilad or private service firms until the sewage treatment system services become installed.

8.1.4 Necessity /Justification for Japanese Technical Grant

Japan is very much experienced in strategic and/or master planning and in implementing sewerage and sanitation, and is eager to apply the achievements in such planning to help developing countries in reaching their respective goals. The Japanese government accomplishes this through technical support programs using ODA grants and loans.

A number of Japanese technical and financial assistance projects for environmental improvement (by MWSS and LWUA) and for flood controls (by DPWH) have been implemented in Philippines. Regarding support provided by JICA to the sewerage sector in the Philippines, it has so far conducted the Metro Manila Waterworks and Sewerage Master Plan Study, constructed sewerage and sanitation management facilities in several provinces and cities via grant aid and yen loans, and conducted support for water quality improvement and water quality management via technical cooperation. Also, from April to August 2009, JICA implemented the Preparatory Survey for Metro Manila Sewerage and Sanitation Improvement Phase I, which aimed to collect information on development plans, project implementation plans and support for sewerage system construction and sanitary environmental improvement in Metro Manila and to offer recommendations geared to realizing projects for sewage treatment and drainage facilities construction, river purification and sanitary environmental system improvement based on the local needs. Therefore, with its accumulated experiences and technological know-how, Japan as a partner in development will be able to assist Metro Manila in achieving its development goals and environmental improvement projects in the most effective manner and within the shortest time possible.

8.2 Applicable Alternatives of Project Recommended for Target Areas

8.2.1 Population Projection

According to the 2005 Master Plan of MWSS, population is forecast for every five years from 2010 to 2025 as shown in T**able 8-2-1**. However, these forecast values differ greatly from the forecasts made by MWSI in 2008.

Table 8-2-1 MWSS Master Plan (2005)

	2005	2010	2015	2020	2025
Parañaque	498,242	544,239	588,518	628,723	663,185
Las Piñas	559,481	652,906	754,286	860,899	970,158

According to the 2008 Business Plan of MWSI, population is forecast as shown in **Table 8-2-2**, and this again differs greatly from the figures shown in **Table 8-2-1.**

Table 8-2-2 MWSI Business Plan (2008)

	2007	2010	2015	2020	2025	2030	2036
Parañaque	557,857	584,194	626,609	663,697	695,091	720,653	740,871
Las Piñas	535,208	556,594	586,701	611,298	630,393	644,181	652,737

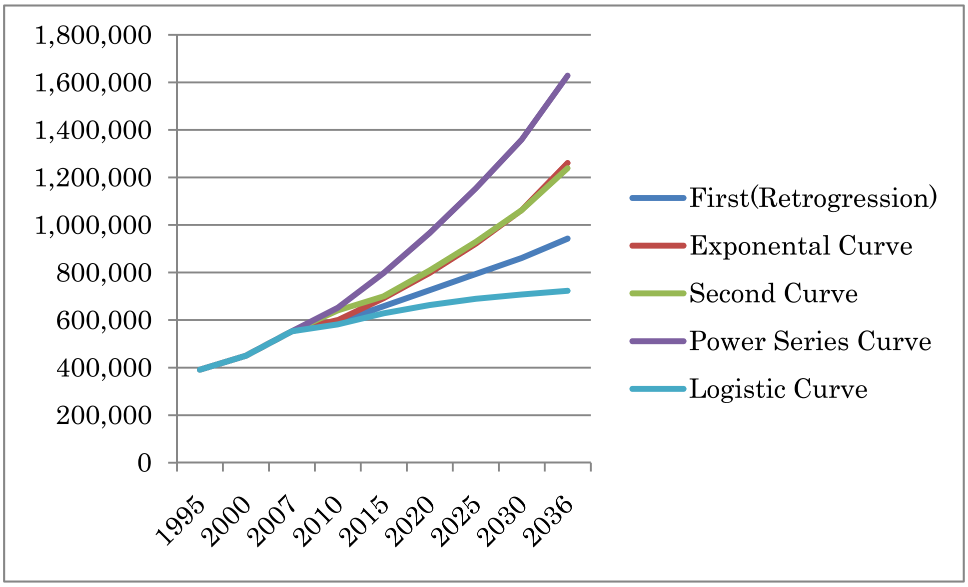
Therefore, the population in both cities shall be estimated in the Project. The target year for the Project shall be matched with the target year of the MWSI Business Plan, i.e. 2036.

1) Parañaque

The average rate of population growth in Paranaque from 1995 to 2007 was a steady 2.2%. The growth rate between 1995 and 2000 was high at 3.03% but slowed down to 2.88% between 2000 and 2007. The average population density in 2007 was 117 people per hectare. The past population figures of Paranaque shall be used to forecast population in 2036. Out of the five formulae indicated in **Table 8-2-3**, the logistic curve formula, which gives a similar forecast to the MWSI forecast, is adopted and the design population in the target year of 2036 is determined as 740,871.

Table 8-2-3 Parañaque Estimated Population

	First(Retrogression)	Exponental Curve	Second Curve	Power Series Curve	Logistic Curve
1995	391,296	391,296	391,296	391,296	391,296
2000	449,811	449,811	449,811	449,811	449,811
2007	552,660	552,660	552,660	552,660	552,660
2010	590,841	599,767	640,212	651,986	582,048
2015	658,476	691,926	700,099	798,235	627,930
2020	726,111	798,245	808,443	966,135	663,148
2025	793,746	920,901	929,243	1,153,583	689,189
2030	861,381	1,062,405	1,062,501	1,359,022	707,918
2036	942,543	1,261,195	1,238,854	1,627,597	723,236

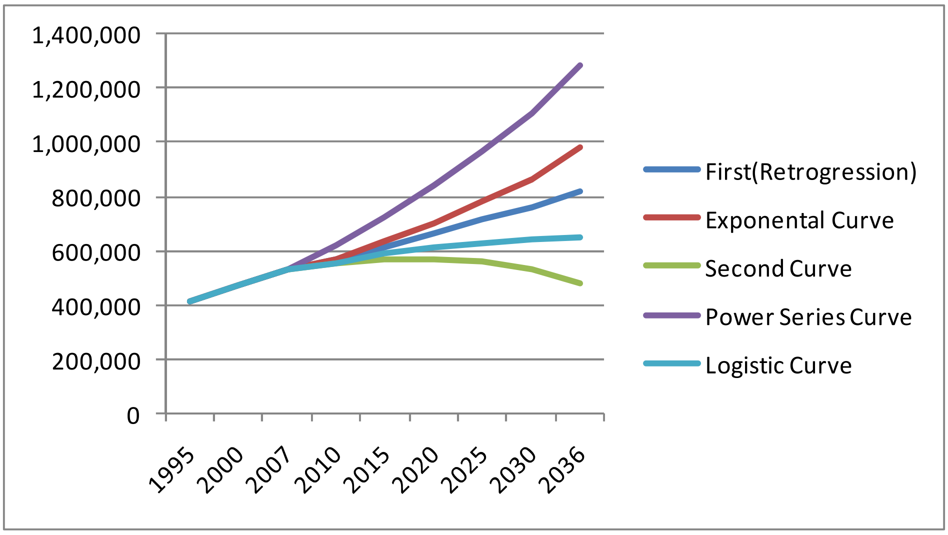


2) Las Piñas

The average rate of population growth in Las Piñas from 1995 to 2007 was a steady 2.1%. The growth rate between 1995 and 2000 was high at 2.93% but slowed down to 1.65% between 2000 and 2007. The average population density in 2007 was 135 people per hectare. The past population figures of Las Piñas shall be used to forecast population in 2036. Out of the five formulae indicated in **Table 8-2-4**, the logistic curve formula, which gives a similar forecast to the MWSI forecast, is adopted and the design population in the target year of 2036 is determined as 652,737.

Table 8-2-4 Las Piñas Estimated Population

	First(Retrogression)	Exponental Curve	Second Curve	Power Series Curve	Logistic Curve
1995	413,086	413,086	413,086	413,086	413,086
2000	472,780	472,780	472,780	472,780	472,780
2007	532,330	532,330	532,330	532,330	532,330
2010	564,620	570,598	549,272	618,410	555,836
2015	613,846	633,081	566,071	723,615	586,388
2020	663,072	702,406	568,571	841,101	609,652
2025	712,298	779,321	556,772	969,402	626,918
2030	761,524	864,660	530,675	1,107,456	639,492
2036	820,595	979,490	480,484	1,284,861	649,988



8.2.2 Organization of sewage Treatment Plants

1) Sub Catchment Areas and Sub Basin Borders

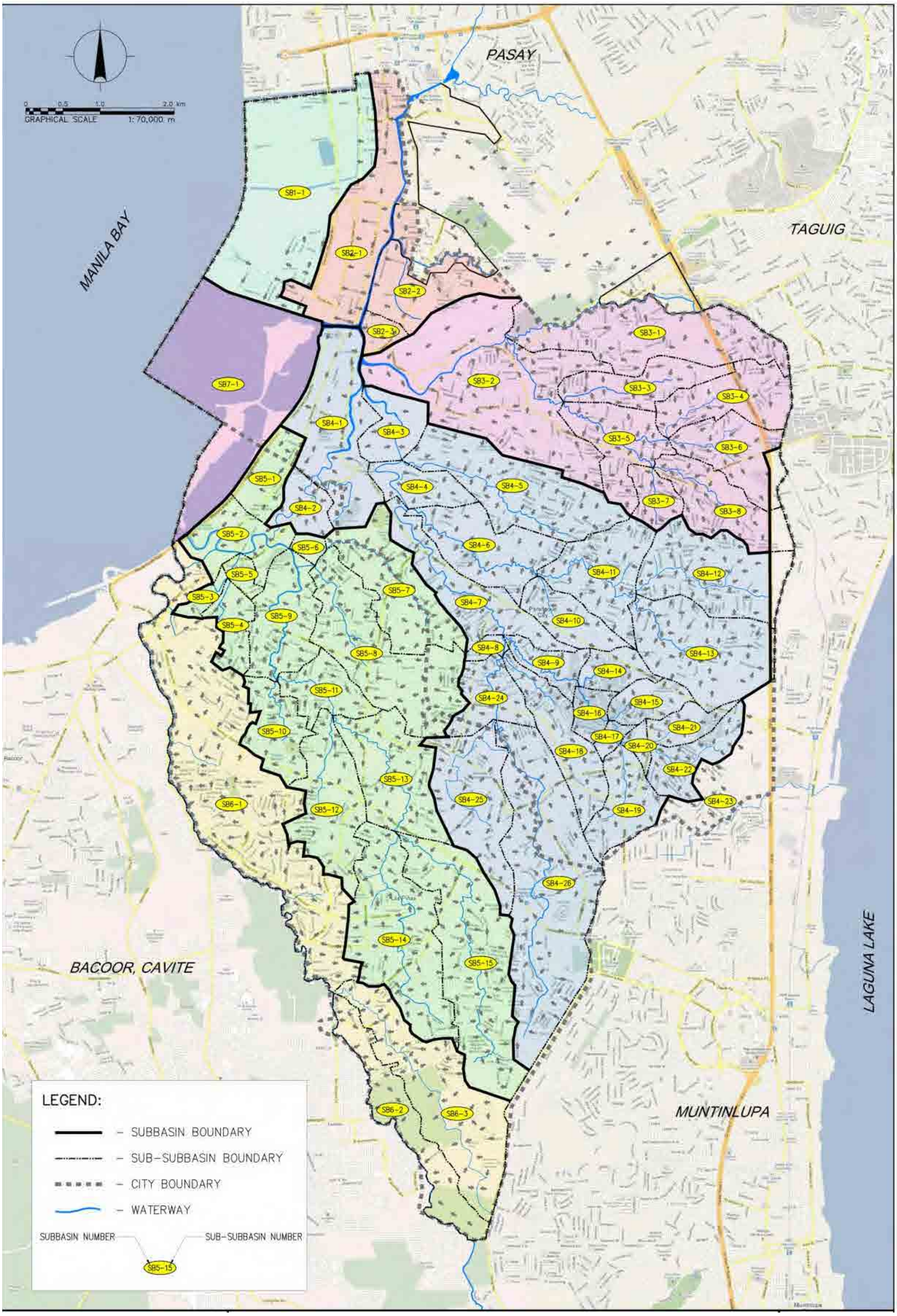
(1) Parañaque and Las Piñas

The administrative district of Parañaque covers approximately 77.34 km^2. **Figure8-2-1** shows the map of catchment areas in Parañaque and Las Piñas. Sub-basins in the two cities are broadly divided into seven catchment areas and 57 smaller basins. In Parañaque, sanitary sewage flows in from part of Pasay and part of Las Pinas. **Table8-2-5** shows the area of the Parañaque and Las Pinas sub-basins and population in 2036.

Table 8-2-5 Parañaque and Las Pinas sub-basins and population in 2036

Basin Area	2036		Note (Sub-Sub-Basin)
	Area(ha)	Population	
SB1	248.71	92,435	SB1-1
SB2	348.51	78,720	SB2-1～SB2-3
SB3	1,195.00	165,836	SB3-1～SB3-8
SB4	2,979.45	487,507	SB4-1～SB4-26
SB5	1,869.16	395,769	SB5-1～SB5-15
SB6	972.92	173,341	SB6-1～SB6-3
SB7	0.00	0	SB7-1
Sub Total	7,734.01	1,393,608	
Pasay	201.78	86,022	PP-1, PP-2
Total	7,935.79	1,479,630	

Figure 8-2-1 Map of Catchment Area(Parañaque、Las Piñas)



2) Centralization and Localization of Sewage Treatment Plants

The sewage treatment plants' locations are decided in order to achieve most effective and economic sewerage systems covering the project target areas. The essential identifications to decide the sewage plant locations shall be studied as followings.

(1) Definition of Parañaque Basin as the Project Target Area

The direct objective of the feasibility study of Parañaque Basin sewerage project is to improve the surface water qualities of Parañaque and Las Piñas Cities by treating the untreated wastewater generated in the project areas before discharged into the waterways in the basin. Therefore the project area borderlines are decided by identifying wastewater gravity flow directions on the topographical highest level lines surrounding the river and tributaries. Thus all wastewater gravity flows in a sub-basin are discharging into the water receiving body in the basin within the borderlines, and all wastewater gravity flows outside the lines are directing into the other receiving bodies.

(2) The Features of the Project Area Terrain

The target basin consists of 26 sub basins, and all basins have outfalls at the far ends of drainages or esteros to the final discharging creeks or rivers. thus finally all wastewater generated in the project areas is discharged into the river or its tributaries in the sub-basins.

(3) Method of Sewage Water Collection

Because of very congested areas of the project areas, and avoiding huge cost and construction impact in the areas, combined sewer collection system is applied.

(4) Sewage Treatment Plant Positioning

In order to reduce sewerage system construction cost, gravity flow sewage water collection is applied as much as possible. Consequently the sewage plant location would preferably be positioned at the lowest ground level or its vicinity in the basin.

(5) Sewage Treatment Plant Construction Scheme

Establishment of sewerage treatment scheme is generally divided into two systems regarding the sewage treatment plant construction. One is centralization and another is localization. The decisions make to select which scheme is most applicable, shall be done with various conditions such as, project area ground conditions, land procurement for sewage plants, environmental and social conditions, sewerage system development plan, difficulty of installation of piping works, project area size, budgetary conditions, local resident requirement, creation of local employment opportunity, etc.

Taking consideration the project areas which consist of 26 sub basins, the sewage treatment plants' locations and numbers shall be selected with studies of constitutions of the project basin areas, difficulty of enough land procurement, reduction of capital cost of construction, maintenance easiness, system security, and so on.

The scheme comparison of sewerage treatment system is as follows.

a) Total Construction Size

Because total sewage water flow rate is same in any case, total structure size is basically same, it means total land area required must be same. It is true that in centralization, some parts of water tank walls can be commonly used, but total land occupation is almost same. In case of centralization, big size of machines like blowers, pumps, etc can be applied, but because of operation efficiency and security of the system, it is limited. Big size machines are generally difficult to repair and maintain, so big size stand-by machines are required. Therefore total construction capital cost is almost same but operation cost would become larger in some case.

b) Sewage Water Collection System

Because of topographical reason, the wastewater generated in each sub basin is collected by gravity flow pipes and discharged into receiving bodies at each sub basin outfalls. In the combined sewage collection system, conversion manholes installed at the outfall positions convert the sewage water into the interceptor. The localized sewage treatment plant is located at the lowest area of the basin or its vicinity, thus most sewage water conveyance is done by gravity flow in the interceptor, in order to reduce sewage water transportation cost and for few maintenance purposes.

c) Additional Facilities for Centralization System

Local sewage collection figure for the centralization is not different from the localization. Different function to realize the centralized treatment is the additional facilities and in most cases, more land for pump stations. The transportation pipe works with intermittent pumping stations to convey the local collected sewage to the central sewage treatment plant are essential. Lift up pumping system would be used but more pump stations and larger size pipes are required. In the case of force main system, the pressurizing pump stations should be installed at the same positions of local sewerage treatment plant site and each pumping station needs connection pressure pipes to the force main. The force main pipe should be doubled to avoid whole system down by the pipe damage or maintenance. In the case of lift pumping system, the lift-up stations would be installed at the same positions of the localized plants. And more lift stations might be required to keep 4 to 6‰ of pipe recline and pipe size should be incremented as down streaming. And sewer lines must cross over the many creeks or esteros, siphoning pipes with manholes or sub lift stations with overhead sewer pipes are required at each waterways crossing over. Because of small vacant lands are planned to be used for construction of local sewerage treatment plants, those lands would not be separated for sell by the owners, therefore eventually the whole areas should be procured for the additional pumping stations, that is, land procurement cost for centralization shall be larger far for localization.

d) Operation and Maintenance Staff

In many cases, operation staff numbers are not so much different, even though monitoring management system would be applied.

e) Monitoring Laboratory for Water Quality Management

In both cases, only one local laboratory would be prepared. The features and size of the laboratory is the same.

f) Periodical or Emergent Plant Stop

Periodical maintenance plant stops or some accidental plant stops are assumed. In the case, whole sewerage treatment system by centralization is stopped and localization system causes only limited local area service stop.

g) Sewage Water Transportation Pipe

In the case of lift station system, transportation pipe damage will stop all area sewerage service and suspension of whole system will continue until full recovery of the facilities In the case of pressure main, same trouble happens, but in order to avoid full shut down of the whole system, duplicated force main system shall be applied, but still suspension of the system service will continue until all transfer valves changed over. And also provision shall be made for force main pumps to protect themselves from broken down by the water hummer when the pump stops. The far end of the force main pipe diameter shall be large enough to keep inside water flow velocity of 1.2m/s, which sometimes causes higher cost. These piping construction cost shall be added to the centralized treatment system.

h) Pump Stop

Because of maintenance or accidents, there is assumed the pump station to be stopped. In the case, whole centralized system is stopped. In the case of force main with dual force main system the pump station stopped is taken out from the system, but remaining healthy pumping station shall be stopped until the pump station being taken off by valves closing, that is, during that period, whole system is stopped.

i) Sewage Treatment Plant Stop

In the case of accidents or maintenance, the plants would be stopped. The localized sewage treatment plant stops the sewerage services only for its jurisdiction area, but when the centralized plant stops, its service disturbance in the service area is spreading wider, even though the plant configuration of the process and operation systems is divided into several lines.

j) Sewage Sludge Treatment

In the case that sewage sludge is treated at each plant, there is not much difference between localized and centralized plants. However, where the sewage treatment sludge final process is gathered at one plant of the localized plants, sewage sludge transportation will be required for the localized plant scheme. The facility and construction capital cost is not so much different between two systems, but transportation cost for the untreated sewage sludge would be added to the localization system. In the case of centralization system, the large emergency sewage sludge storage tank is required for the plant to address any suspension of sewage sludge treatment process of the centralized system.

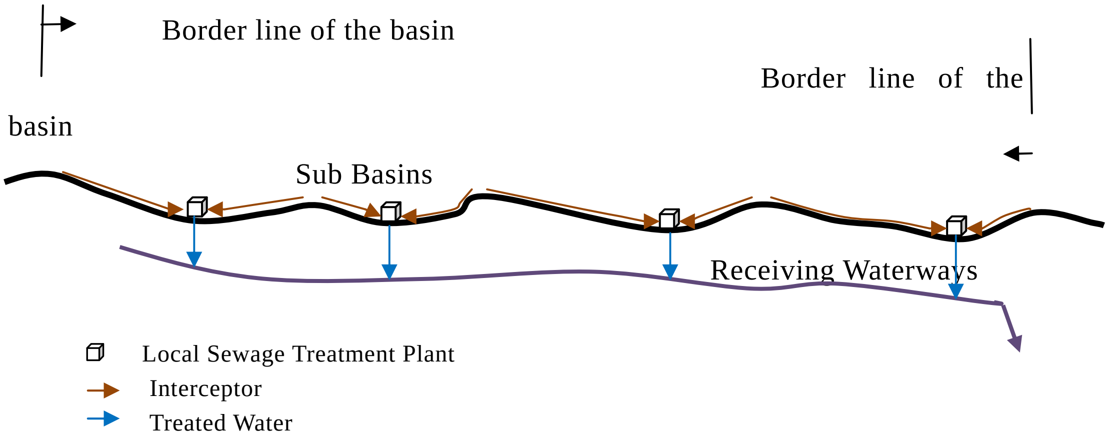
k) Service Commencement Period

Localization could select the construction priority area of the heavy polluted area or residents' strong desire to implement the sewerage system services, and one by one service development can be possible, that is, the sewage service commencement would be faster than centralization. Construction cost and operation cost of centralization would get benefit by construction scale merit, but the scale merit is not so much comparing with additional construction cost to the localization system. Eventually the sewerage service will cover whole service area only by one large sewage treatment plant and therefore the sewerage service could start when whole sewerage system construction is completed, that is, long retention time is necessary (but phasing expansion of the process could be possible).. In order to avoid long service retention time, phasing construction would start from downstream of the river, but facilities should cater for final capacity to serve initial small downstream area service, that is, the cost effectiveness is very low at the beginning, and no choice to implement first for the prioritized areas. And sewerage services for the upstream areas will be very late, even though construction commences simultaneously in whole areas, because the services can only be made when all construction including force main or lift piping works is completed. The worse cost effectiveness should be accepted in the centralization system.

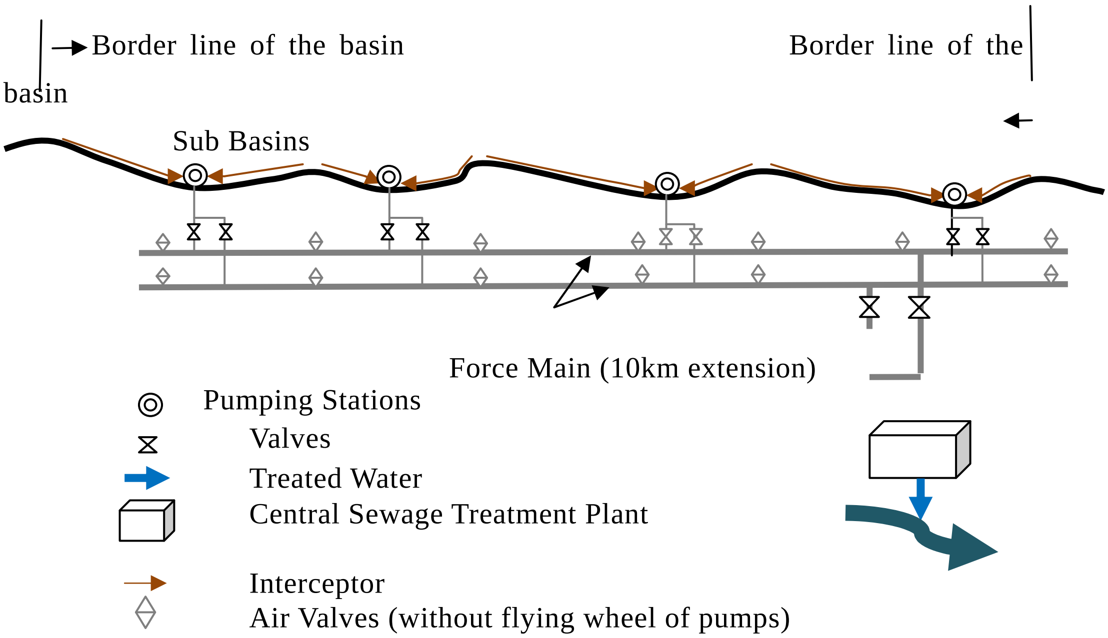
l) Comparison of Sewage Plant Construction Scheme

The conceptual construction scheme comparison between the two systems is explained in the following figures.

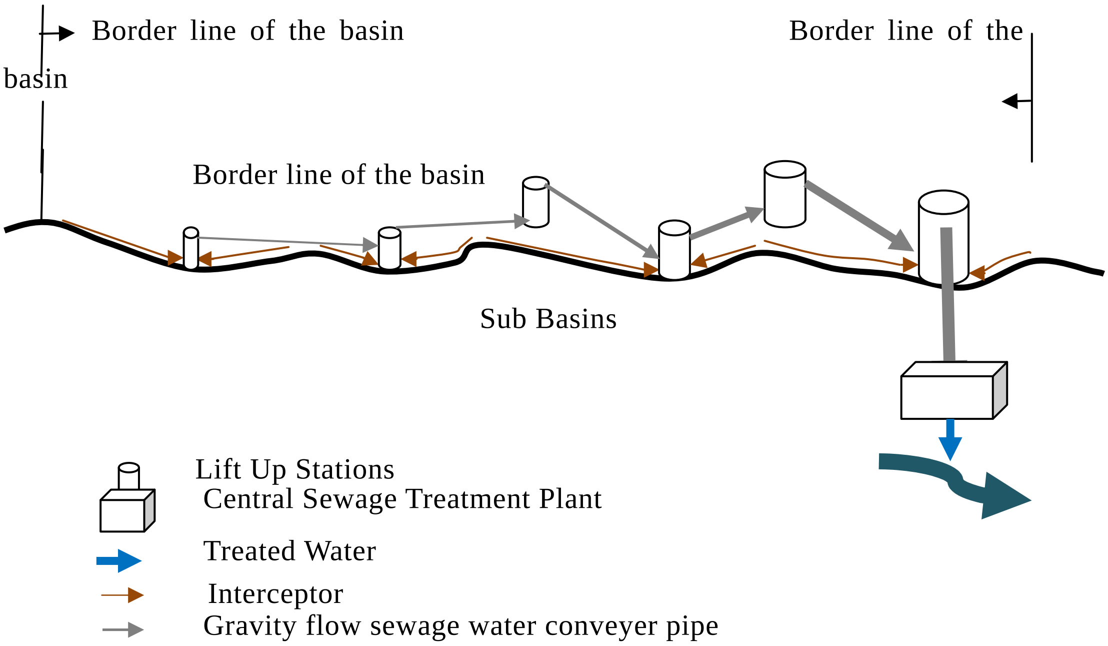
(a)Localized Sewage Treatment System (in each sub basin)



(b) Centralized Sewage Treatment Plant (Force Main)



Centralized Sewage Treatment Plant (Lift-up Stations)



Principal differences between localization and centralization are shown in the comparison table hereunder

Comparison Table of Localization and Centralization of sewage treatment plant

	Localization	Centralization
Cost Effectiveness	Because of selectable construction priority, cost effectiveness is high and fast	The service commencement is not started until whole area is completed, thus cost Effectiveness is low.
Sewage Water Flow	Since plant is located in each sub basin, water flow is natural and capital cost is smaller.	By several intermittent or lift up pumping stations to be required, unnatural water flow routes can be selected.
Sewage Collection	Mainly short extension gravity flow pipes are installed.	Additional long pipe conveyers and pumping stations are required.
Addressing Plant Suspension	Because of limited affection in the sub basin, impact on service areas is small. Recovery period is rather short	A partial suspension may stop whole system, therefore impacts on whole service area. Recovery period in some cases is very long.
Construction Cost	Higher but depends on the terrain	Lower but terrain
Prior Investment	Small	Large, thus low cost efficiency

(m) Conclusion

The most essential factors to choose the sewage plant allocation are geographical terrain and STP site procurement. In the case that geographical terrain of the project target areas are mostly of one side incline and required land space enough to install whole sewage treatment system can be prepared, the centralization is preferable. However, in most cases, the sewage plant s location should be studied in aspect of capital cost (budgetary situation), land procurement, environmental circumstances, urgency of sewage system introduction, technical level required for system operation, population density, geographical conditions, etc.

Treatment districts in the Project shall be examined while considering the advantages and disadvantages of the above small and large treatment districts. The drainage system in the target area can broadly be divided into seven catchment areas. The catchment area in Parañaque covers 4,544.01 ha and comprises five basins, while the catchment area in Las Piñas covers 3,190.0 ha and comprises two basins. Since the sanitary sewage discharged from each household is drained into creeks via outfall sewers, it will be necessary to construct treatment plants at the end of the creeks. The number of treatment plants will be decided upon considering the scale of candidate sites, economy, speed of effect realization and so on. Currently, sanitary sewage from two districts in Pasay flows into Parañaque. **Figure 8-2-2** shows the location of the inflowing districts. In terms of the size of these districts, PP-1 is 168.03 ha, 58,907 people and 10,603m^3/d, while PP-2 is 33.75 ha, 27,115 people and 4,881 m^3/d. Scale of the treatment area will be examined for seven cases considering the geographic features and creeks of the target area and the location of treatment plants. **Table 8-2-6** shows combinations of treatment districts in each case. F**igures 8-2-3** through **8-2-9** show the alternative treatment district proposals.

Case 1: The entire area of Parañaque and Las Piñas is regarded as a single treatment district (one treatment plant). As the treatment plant location, L-C + L-10 (15.60 ha), which is a large site located in the middle of the area and where it is easy to collect sewage, is selected.

Case 2: Parañaque and Las Piñas are each regarded as a single treatment district (two treatment plants). The plants are located at P11 (7.62 ha) in Parañaque and L-C + L-10 (15.60 ha) in Las Piñas.

Case 3: The entire area of Parañaque and Las Piñas is regarded as six treatment districts (four treatment plants in Parañaque and two in Las Piñas). However, since building work has already been started at the P-3 candidate site, which is situated directly below the runway of the airfield, Case 3 has been omitted from the comparative examination

Case 4: The entire area of Parañaque and Las Piñas is regarded as five treatment districts (three treatment plants in Parañaque and two in Las Piñas). The locations are as follows: in Ps district, P11 (7.62 ha), in Pb + Pc district, P-1 (4.50 ha), in Pd + Pe district, P-6 (13.20 ha), in La1 district, L-A (3.25 ha), and in La2 + Lb district, L-C (7.00 ha).

Case 5: The entire area of Parañaque and Las Piñas is regarded as seven treatment districts (five treatment plants in Parañaque and two in Las Piñas). The locations are as follows: in Pa1 + Lb1 district, L-22 (19.00 ha), in Pa2 + Pb2 district, P11 (7.62 ha), in

Pc district, P-1 (4.50 ha), in Pd + Pe district, P-6 (13.20 ha), in La1 district, L-A (3.25 ha), and in La2 + Lb2 district, L-C (7.00 ha).

Case 6: The entire area of Parañaque and Las Piñas is regarded as five treatment districts (three treatment plants in Parañaque and two in Las Piñas). The locations are as follows: in Pa district, P11 (7.62 ha), in Pb + Pc district, P-4 (8.80 ha), in Pd + Pe district, P-6 (13.20 ha), in La1 district, L-A (3.25 ha), and in La2 + Lb district, L-C (7.00 ha).

Case 7: The entire area of Parañaque and Las Piñas is regarded as five treatment districts (three treatment plants in Parañaque and two in Las Piñas). The locations are as follows: in Pa district, P11 (7.62 ha), in Pb + Pc district, P-2 (4.20 ha), in Pd + Pe district, P-6 (13.20 ha), in La1 district, L-A (3.25 ha), and in La2 + Lb district, L-C (7.00 ha).

Case 8: The entire area of Parañaque and Las Piñas is regarded as seven treatment districts (five treatment plants in Parañaque and two in Las Piñas). The locations are as follows: in Pa1 + Lb1 district, L-22 (19.00 ha), in Pa2 + Pb2 district, P11 (7.62 ha), in Pb1 district, P-4 (8.80 ha), in Pc district, P-2 (4.20 ha), in Pd + Pe district, P-6 (13.20 ha), in La1 district, L-A (3.25 ha), and in La2 + Lb2 district, L-C (7.00 ha).

Table 8-2-6 Combinations of Treatment Districts by Case

Case Name	Treatment District Name	ID No	Area(ha)	Puplation	Sewage Volume(m3/d)	Treatment Site(ha)
Case1	Paranaque, Las Pinas	L-C+L10	7,935.79	1,479,630	※266333	Lc+L-10(15.60)
Case2	Paranaque	P-11	5,144.16	908,716	※163569	P-11(7.62)
	Las Pinas	L-C+L10	2,791.63	570,914	102,765	L-C+L-10(15.60)
Case4	Pa	P-11	2,744.46	485,237	87,343	P-11(7.62)
	Pb+Pc	P-1	1,983.75	345,880	※62258	P-1(4.50)
	Pd+Pe	P-6	415.95	77,599	13,968	P-6(13.20)
	La1	L-A	965.31	171,392	30,851	L-A(3.25)
	La2+Lb	L-c	1,826.32	399,522	71,914	L-C(7.00)
Case5	Pa1+Lb1	L-22	1,125.65	216,165	38,910	L-22(19.00)
	Pa2+Pb2	P-11	2,510.76	427,932	77,028	P-11(7.62)
	Pb1	P-4	978.85	160,251	※28845	P-4(8.80)
	Pc	P-1	659.37	137,771	※24799	P-1(4.50)
	Pd+Pe	P-6	415.95	77,599	13,968	P-6(13.20)
	La1	L-A	965.31	171,392	30,851	L-A(3.25)
	La2+Lb2	L-C	1,279.90	288,520	51,934	L-C(7.00)
Case6	Pa	P-11	2,744.46	485,237	87,343	P-11(7.62)
	Pb+Pc	P-4	1,983.75	345,880	※62258	P-4(8.80)
	Pd	P-6	415.95	77,599	13,968	P-6(13.20)
	La1	L-A	965.31	171,392	30,851	L-A(3.25)
	La2+Lb	L-C	1,826.32	399,522	71,914	L-C(7.00)
Case7	Pa	P-11	2,744.46	485,237	87,343	P-11(7.62)
	Pb+Pc	P-2	1,983.75	345,880	※62258	P-2(4.20ha)
	Pd+Pe	P-6	415.95	77,599	13,968	P-6(13.20)
	La1	L-A	965.31	171,392	30,851	L-A(3.25)
	La2+Lb	L-C	1,826.32	399,522	71,914	L-C(7.00)
Case8	Pa1+Lb1	L-22	1,125.65	216,165	38,910	L-22(19.00)
	Pa2+Pb2	P-11	2,510.76	427,932	77,028	P-11(7.62)
	Pb1	P-4	978.85	160,251	※28845	P-4(8.8)
	Pc	P-2	659.37	137,771	※24799	P-2(4.20ha)
	Pd+Pe	P-6	415.95	77,599	13,968	P-6(13.20)
	La1	L-A	965.31	171,392	30,851	L-A(3.25)
	La2+Lb2	L-C	1,279.90	288,520	51,934	L-C(7.00)

Note) (※) This includes inflowing population from Pasay.

Figure 8-2-2 Inflowing Districts from Pasay to Parañaque

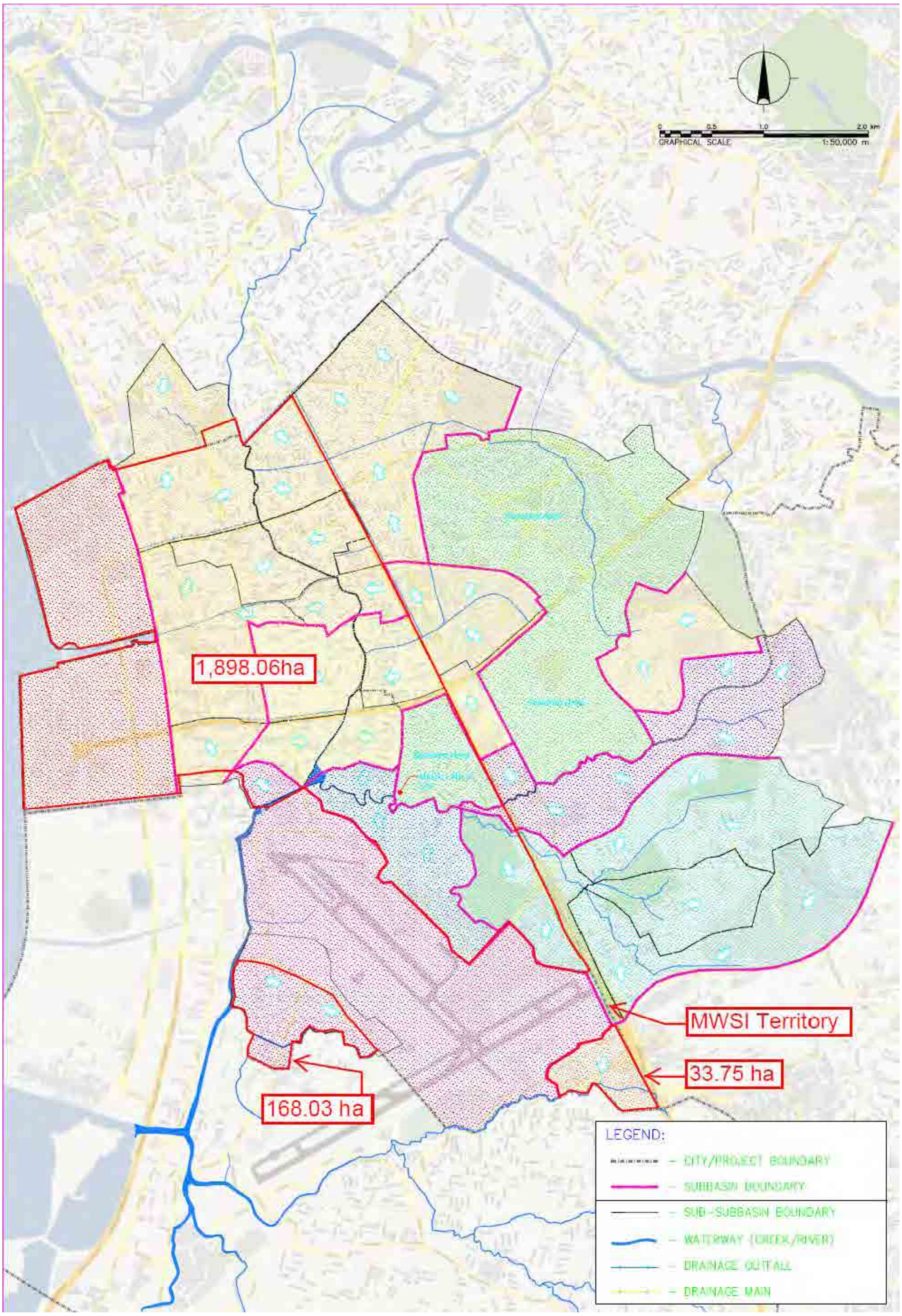


Figure 8-2-3 Case 1 One treatment district (consolidating Parañaque and Las Piñas)

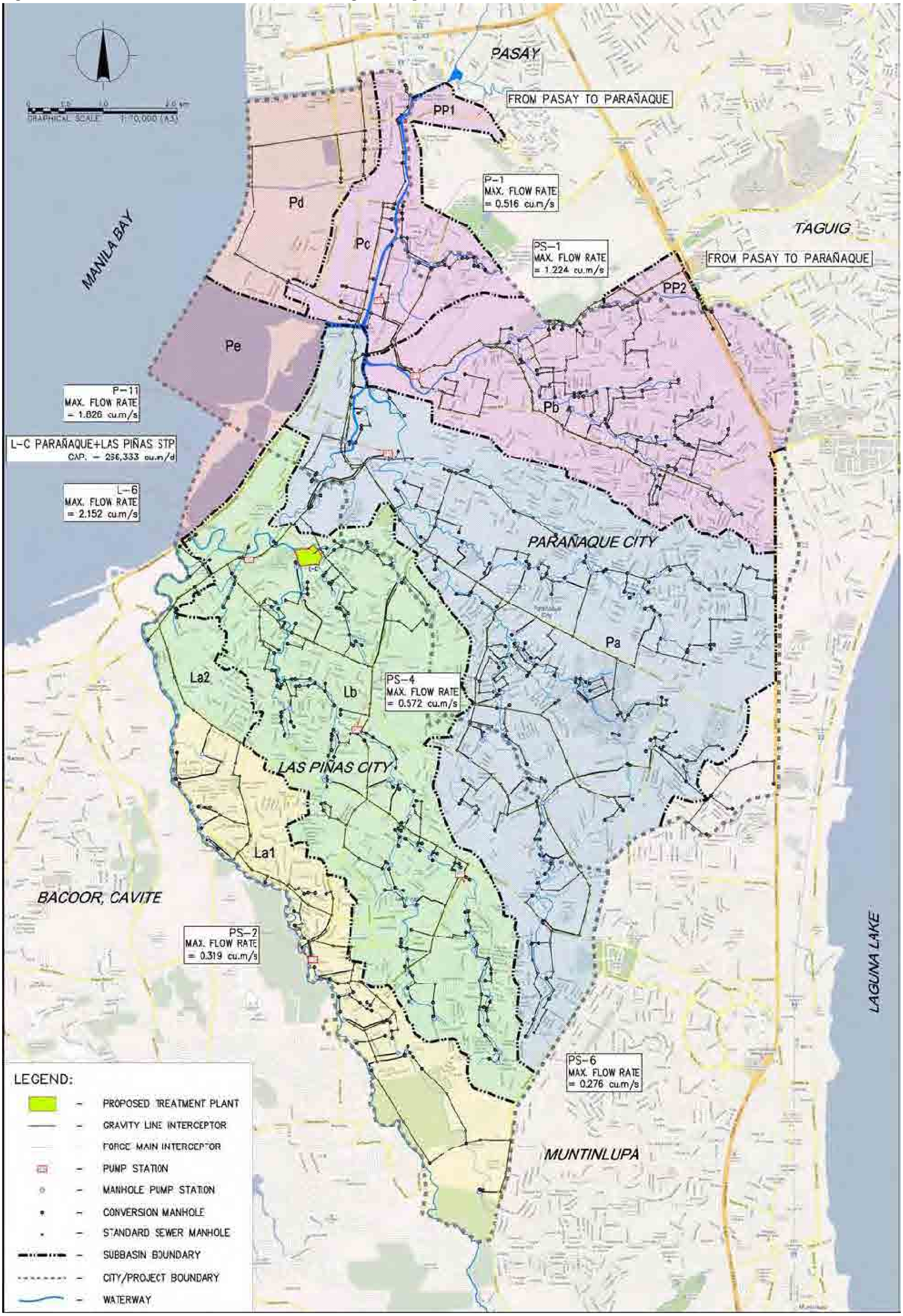


Figure 8-2-4 Case 2 Two treatment districts (Parañaque One STP Las Piñas One STP)

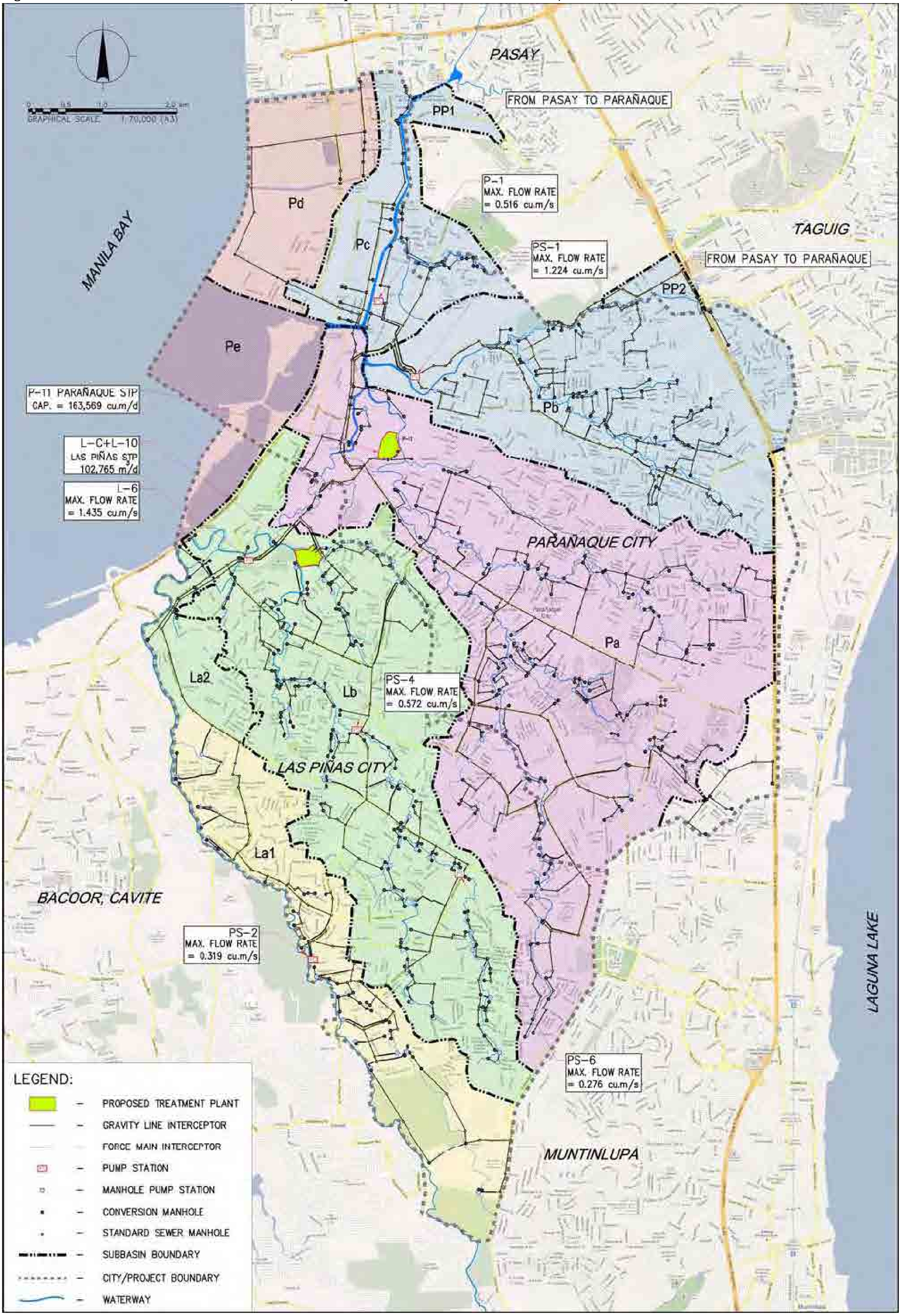


Figure 8-2-5 Case 4 Five treatment districts (Parañaque three STPs　Las Piñas two STPs)

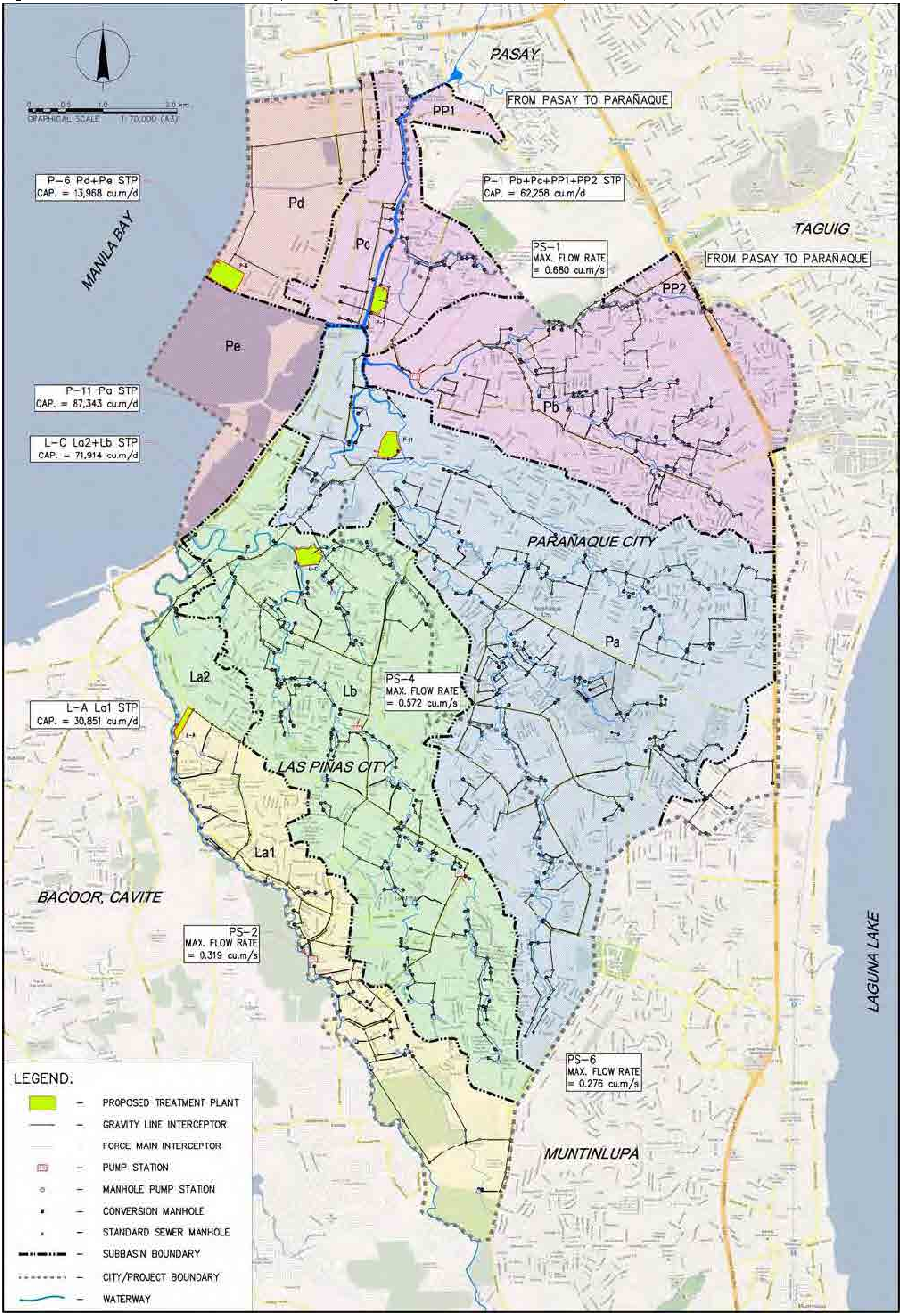


Figure 8-2-6 Case 5 Seven treatment district (Parañaque five STPs　Las Piñas two STPs)

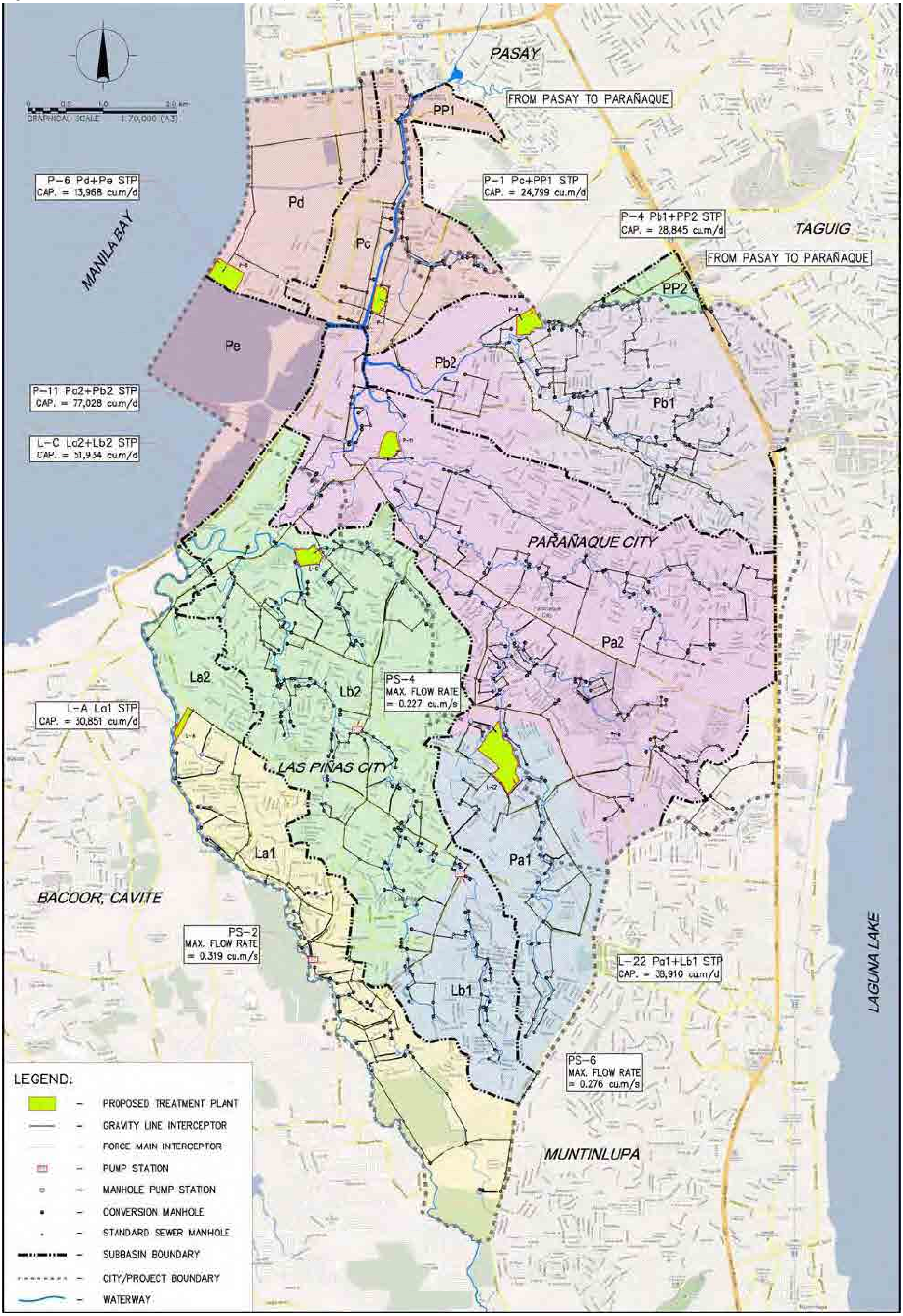


Figure 8-2-7 Case 6 Five treatment districts (Parañaque three STPs Las Piñas two STPs)

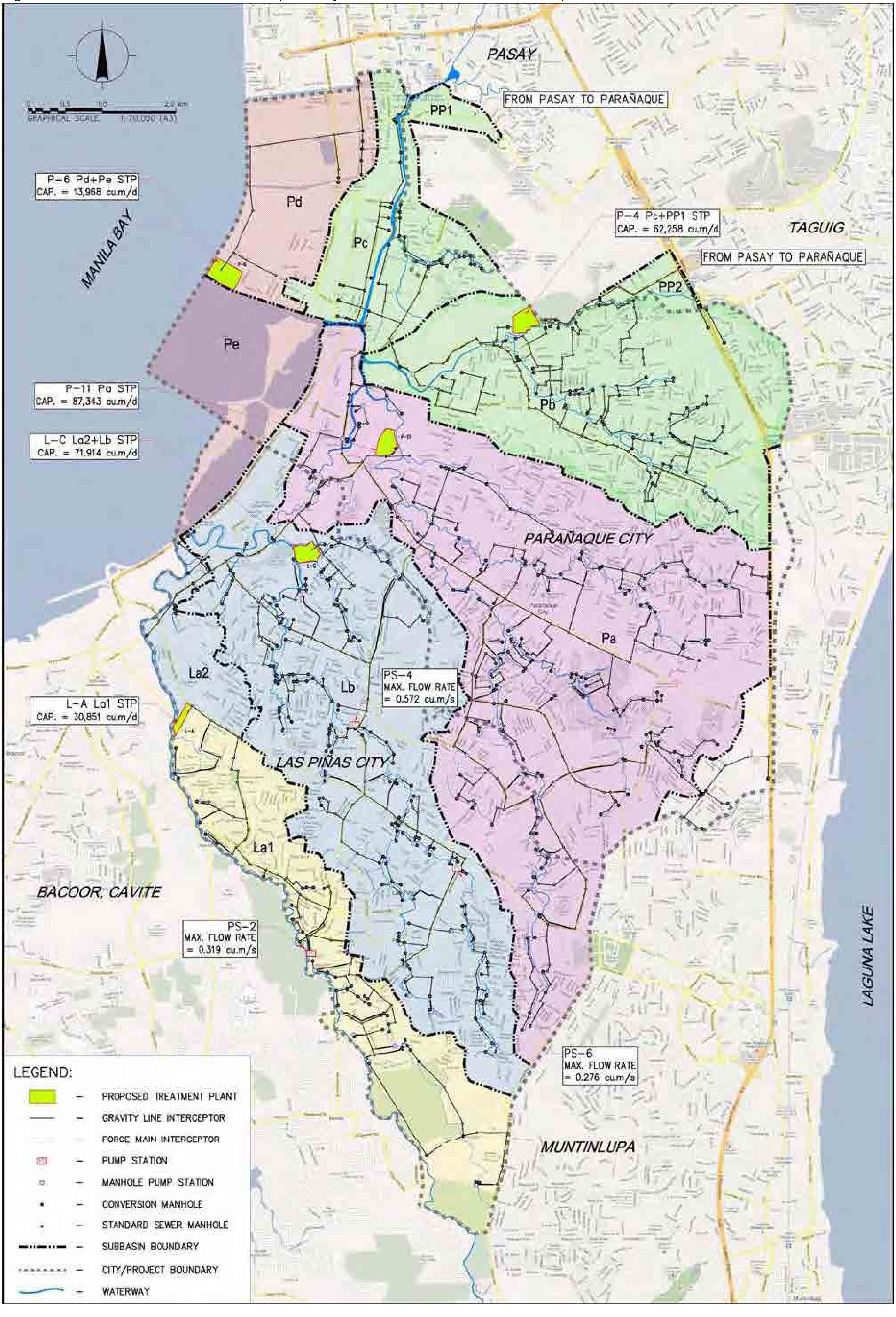


Figure 8-2-8 Case 7 Five treatment districts (Parañaque three STPs　Las Piñas two STPs)

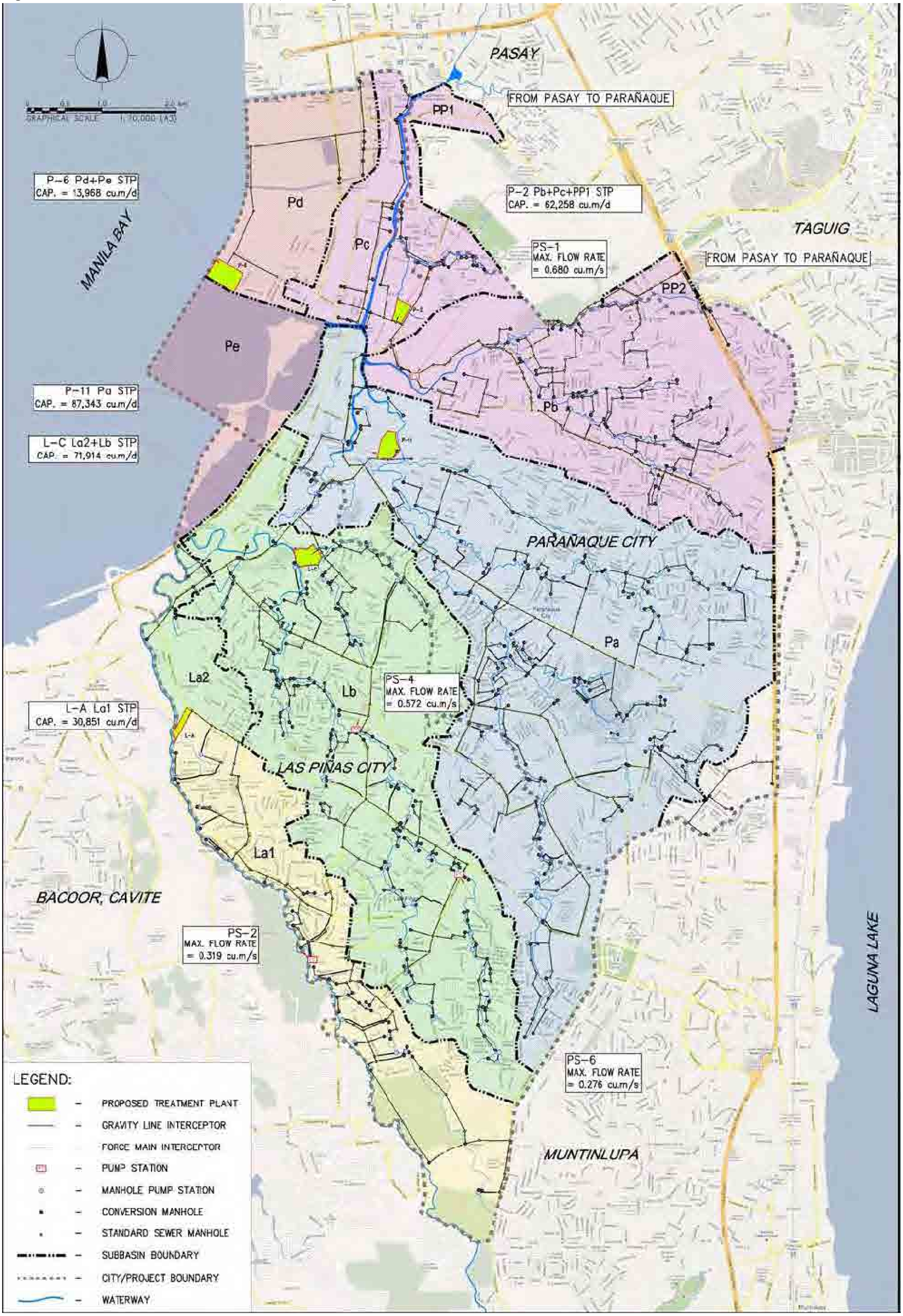
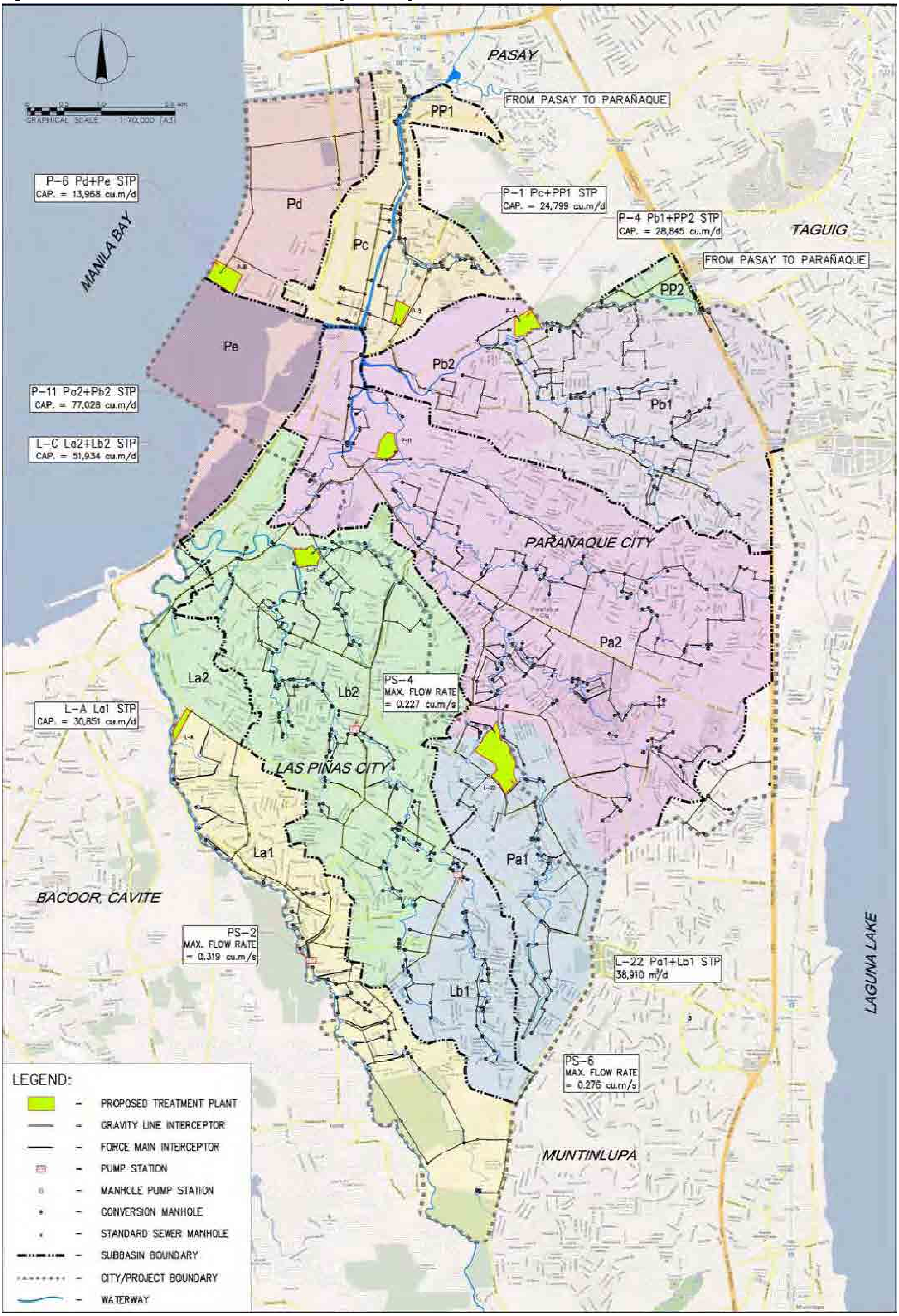


Figure 8-2-9 Case 8 Seven treatment districts (Parañaque five Steps　Las Piñas two STPs)



8.2.3. Applicable Sewage Treatment Process to Each Site Candidate

The scale of the treatment district is deeply related to the treatment system. **Table 8-2-7** shows five treatment systems that can be applied in the Project. Size of the treatment plant site is linked to the treatment method. In the case of the OD process, a large site area is required. In Case 1 and Case 2, where treatment districts are combined into a large size, since the plant area cannot fit into the L-C site alone, the adjoining L-10 site has also been included. Table 7-13 shows the relationship between treatment system and the size of treatment plants that can fit in the candidate locations.

Table 8-2-7 Treatment Plant Candidate Sites (Site Area) and Treatment Processes

Case Name	Treatment District Name	ID No, Area (ha)	Sewage Volume (m^3/d)	OD	CAS	SBR	MBBR	MBR
Case1	Paranaque, Las Pinas	Lc+L-10(15.60)	266,333	×	○	○	○	○
Case2	Paranaque	P-11(7.62)	163,569	×	○	○	○	○
	Las Pinas	Lc+L-10(15.60)	102,765	○	○	○	○	○
Case4	Pa	P-11(7.62)	87,343	×	○	○	○	○
	Pb+Pc	P-1(4.50)	62,258	×	○	○	○	○
	Pd+Pe	P-6(13.20)	13,968	○	○	○	○	○
	La1	L-A(3.25)	30,851	×	○	○	○	○
	La2+Lb	Lc(7.00)	71,914	×	○	○	○	○
Case5	Pa1+Lb1	L-22(19.00)	38,910	○	○	○	○	○
	Pa2+Pb2	P-11(7.62)	77,028	×	○	○	○	○
	Pb1	P-4(8.80)	28,845	○	○	○	○	○
	Pc	P-1(4.50)	24,799	○	○	○	○	○
	Pd+Pe	P-6(13.20)	13,968	○	○	○	○	○
	La1	L-A(3.25)	30,851	×	○	○	○	○
	La2+Lb2	Lc(7.00)	51,934	○	○	○	○	○
Case6	Pa	P-11(7.62)	87,343	×	○	○	○	○
	Pb+Pc	P-4(8.80)	62,258	○	○	○	○	○
	Pd	P-6(13.20)	13,968	○	○	○	○	○
	La1	L-A(3.25)	30,851	×	○	○	○	○
	La2+Lb	Lc(7.00)	71,914	×	○	○	○	○
Case7	Pa	P-11(7.62)	87,343	×	○	○	○	○
	Pb+Pc	P-2(4.20ha)	62,258	×	○	○	○	○
	Pd+Pe	P-6(13.20)	13,968	○	○	○	○	○
	La1	L-A(3.25)	30,851	×	○	○	○	○
	La2+Lb	Lc(7.00)	71,914	×	○	○	○	○
Case8	Pa1+Lb1	L-22(19.00)	38,910	○	○	○	○	○
	Pa2+Pb2	P-11(7.62)	77,028	×	○	○	○	○
	Pb1	P-4(8.8)	28,845	○	○	○	○	○
	Pc	P-2(4.20ha)	24,799	○	○	○	○	○
	Pd+Pe	P-6(13.20)	13,968	○	○	○	○	○
	La1	L-A(3.25)	30,851	×	○	○	○	○
	La2+Lb2	Lc(7.00)	51,934	○	○	○	○	○

Note) 1) In the table, 'x' indicates treatment processes that cannot fit on sites, while '○' indicates treatment processes that can.

2) OD: Oxidation Ditch Process, CAS: Conventional Activated Sludge Process,
SBR: Sequencing Batch Reactor, MBBR: Moving Bed Bio Reactor,
MBR: Membrane Bio Reactor

8.2.4 Comparison of Applicable Sewage Treatment Process

1) Comparison of Advantages and Disadvantages

In this section, regarding the relationship between treatment method and site and securing of the treatment plant site, etc. we compare the advantages and disadvantages of eight cases, i.e. Case 1~Case 8. All of the five treatment processes are applicable, however, the final decision will be made upon considering all factors including construction cost and maintenance, etc. **Table 8-2-8** shows the comparison of each case in terms of securing of site, etc.

Table 8-2-8 Comparison of Advantages and Disadvantages in Each Case

	Case1	Case2	Case4	Case5	Case6	Case7	Case8
1. Compatibility with the treatment plant candidate site	7	6	4	4	1	1	1
2. Ease/difficulty of securing treatment plant site	7	6	1	1	1	1	1
3. Electric power consumption	6	7	3	1	3	3	1
4. Number of operators	1	2	3	6	3	3	6
5. Speed of realization of sewerage construction effect	7	6	3	1	3	3	1
6. Speed of water quality preservation effect in the outfall water body	7	6	3	1	3	3	1
7. Handling of former salt field (P-1)	1	1	6	6	1	1	1

{Considerations}

1. Compatibility with the treatment plant candidate site

In Case 1 and Case 2, the treatment plant can only fit into candidate site L-C if the adjacent L-10 is included. In Cases 4 and 5, because the access road to the plant site is narrow, the impacts of noise and vibration are large; moreover, construction cost increases because it is necessary to fill in and level a pond.

2. Ease/difficulty of securing treatment plant site

The land for expansion (L-10) in Cases 1 and 2 faces the road that connects to C5, meaning that it will be difficult to secure site land.

3. Electric power consumption

Power consumption is smallest in cases where the OD process, which is an energy saving method, can be largely adopted.

4. Number of operators

As in Case 1 and Case 2, personnel expenses for operators can be reduced when the scale of incoming water is large.

5. Speed of realization of sewerage construction effect

Through dispersing the treatment districts, improvement of water quality in creeks and rivers and improvement in the living environment for local residents can be achieved more quickly.

6. Speed of water quality preservation effect in the outfall water body

Through dispersing treatment districts and constructing treatment plants in upstream areas, the water quality preservation effect in outfall water bodies will be realized faster and a model of water quality environmental improvement will be provided for other areas.

7. Handling of former salt field (P-1)

The P-1 candidate site in Cases 4 and 5 serves as a drainage basin at times of flooding, and this function should be retained rather than using it as a site for a treatment plant.

2) Technical Comparison of Alternatives

In addition to the case-separate comparison of advantages and disadvantages in **Table 8-2-8**, a general comparison including maintenance and construction costs shall be conducted. **Table 8-2-9** shows a comparison of combinations of each treatment district.

Table 8-2-9 Environmental and social consideration refers to the giving of consideration to impacts on natural elements such as air, water, soil, ecosystem and biota, etc. and social impacts such as involuntary resettlement of residents and respect for the human rights of indigenous peoples, etc. In this section, examination is conducted on treatment plant construction, interceptor construction and items that have an impact on environment and society following construction.

{Considerations}

Maintenance is easier if the OD process is adopted in more places. Compared to the other processes, the OD process entails fewer instruments and easier inspections. Case 5 and Case 8 are advantageous.

9. Ease of construction of interceptors

In Case 5 and Case 8, treatment facilities are located in middle and upper reaches, and the interceptor sewers downstream of them have small cross sections, thereby enabling easier construction works and cheaper construction costs.

10. Nitrogen removal capacity

Controls on nitrogen and phosphorous are not currently enforced in Manila Bay, however, such controls will be adopted sooner or later. The OD process has the highest nitrogen removal capacity, followed by the SBR and MBR processes. Therefore, Case 5 and Case 8 are advantageous because they entail adoption of the OD process at numerous sites.

11. Environmental and Social Considerations

The examination items are almost all the same in each case; however, they are linked to the speed of the water quality conservation effect in discharge water bodies. If the treatment plant is installed and treated effluent is discharged upstream as in Case 8, the living environment will be changed radically compared to the current dirty and odorous state of creeks. Case 8 is also advantageous in terms of environmental and social consideration.

12. Construction cost

As is shown in **Table 8-1-6**, following Case 8, Case 5 entails the lowest construction cost and maintenance cost not including the site expenses for the treatment plant.

｛**Treatment Process Recommended**｝

As conclusion for sewage treatment process selection, OD is the most recommendable and SBR is the second. However, several candidate site are not sufficient to accommodate CD process, thus OD will be selected for the candidate sites with enough area space for OD, otherwise SBR will be selected (refer **Table 8-2-41)**

Table 8-2-9 General Comparison of Cases

		Case 1	Case 2	Case 4	Case 5	Case 6	Case 7	Case 8
1. Compatibility with the treatment plant candidate site		7	6	4	4	1	1	1
2. Ease/difficulty of securing treatment plant site		7	6	1	1	1	1	1
3. Electric power consumption		7	6	3	1	3	3	1
4. Number of operators		1	2	3	6	3	3	6
5. Speed of realization of sewerage construction effect		7	6	3	1	3	3	1
6. Speed of water quality preservation effect in the outfall water body		7	6	3	1	3	3	1
7. Handling of former salt field (P-1)		1	1	6	6	1	1	1
8. Ease/difficulty of maintenance		7	6	4	1	3	4	1
9. Ease of construction of interceptor		7	6	3	1	3	3	1
10. Nitrogen removal capacity		7	4	4	1	3	4	1
11. Environmental and Social Considerations	Air Pollution	1	1	1	1	1	1	1
	Water Pollution	7	6	3	1	3	3	1
	Noise and Vibrations	1	1	1	1	1	1	1
	Offensive Odors	1	1	1	1	1	1	1
	Employment	7	6	3	1	3	3	1
	Resettlement of residents	1	1	1	1	1	1	1
12. Construction Cost		6	2	5	1	3	7	4
Overall Score		82	67	49	30	37	43	25
Judgment		7	6	5	2	3	4	1

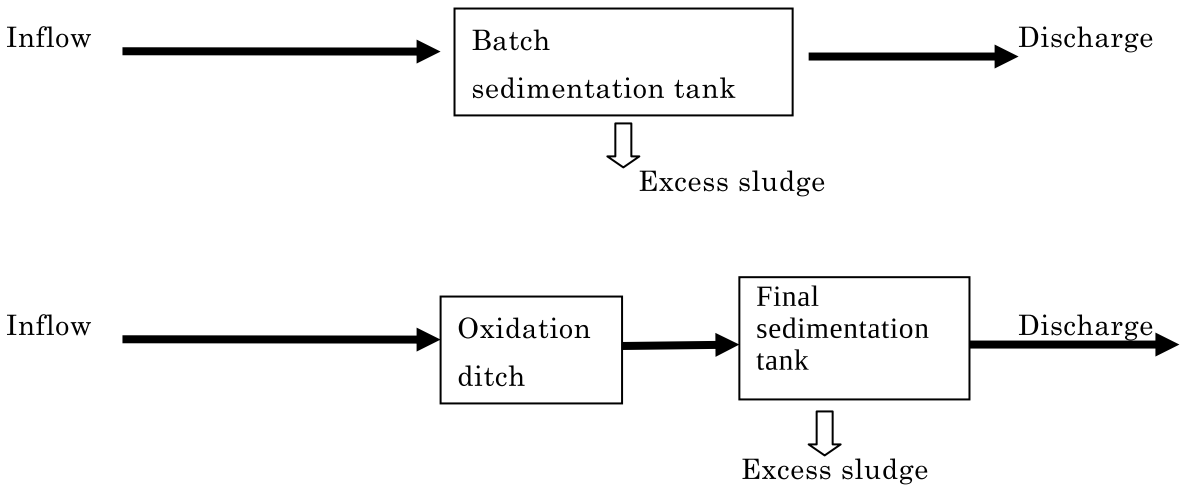
Note) For items 1 and 2, order is determined in terms of the ease of purchasing land. For item 3, order is determined in terms of the least electricity consumption. For item 4, order is determined in terms of the fewest operating staff. For items 5 and 6, order is determined in terms of the fastest construction effect. For item 7, order is set with a view to retaining the water retarding function of P-1. For item 8, order is determined in terms of the frequency of adoption of the OD method, which requires easy maintenance. For item 9, order is determined with a view to reducing the cross section of interceptors. For item 10, order is determined in terms of the frequency of adoption of the OD method and SBR method, which provide high nitrogen removal capacity. Concerning item 11, conditions are the same for all cases in terms of air pollution, noise and vibrations and there is no resettlement of residents due to acquisition of land for the treatment plant. Concerning water pollution, effluent from the treatment facilities satisfies the wastewater discharge standard in all cases, however, Cases 5 and 8, which entail constructing the treatment plant in the upstream area, are ranked higher because they enable a faster water quality improvement effect. In terms of employment, since more employment opportunities for local residents are created as the number of treatment plants increases, the cases with the greater number of plants are ranked higher.

8.2.5 Applicable Sewage Sludge Treatment Process

1) Recommendable Sewage Sludge Treatment Systems
(1) Design Conditions for the Sludge Treatment Facilities

Sanitary sewage generated from Parañaque/Las Piñas is scheduled for treatment at seven treatment plant. It is proposed that the sequencing batch reactor process (SBR) and the Oxidation ditch process be adopted for sewage treatment process at these facilities, and the outline flow of this is as indicated in **Figure 8-2-10**.

Figure 8-2-10 Outline Flow of the Sequencing Batch Reactor Process and the Oxidation ditch process



Parameters for sewage sludge calculations shall be done with the following figures.

- Properties of batch generated sludge (excess sludge)
  Type of sludge: Excess sludge
  Solids generation rate: 75% of removed SS according to **Table 6-2-1**
  Sludge concentration: 0.6% according to **Table 6-2-2**
- Properties of batch generated sludge (excess sludge)
  Type of sludge: Excess sludge
  Solids generation rate: 75% of removed SS according to **Table 6-2-1**
  Sludge concentration: 0.6% according to **Table 6-2-2**

Table 8-2-10 shows the results of calculations for sewage sludge generation rate at each STPs.

Table 8-2-10 Sewage Sludge Generation Rate of Each

Items	unit	Pa1+Lb1 STP	Pa2+Pb2 STP	Pb1 STP	Pc STP	Pd+Pe STP	La1 STP	La2+Lb2 STP
STP Location ID No.	－	L-22	P-11	P-4	P-2	P-6	L-A	L-C
1.Design Condition								
1)Design Flow								
Dry Flow	m^3/d	39,000	77,100	28,900	24,800	14,000	30,900	52,000
2)Design Water Quality								
BOD	mg/l	220	220	220	220	220	220	220
SS	mg/l	225	225	225	225	225	225	225
3) Water Treatment Process	－	OD	SBR	OD	OD	OD	SBR	OD
4)Effluent Water Quality								
BOD	mg/l	20	20	20	20	20	20	20
SS	mg/l	30	30	30	30	30	30	30
5)Generated Sludge Volume								
Solids	t/d	5.71	11.27	4.23	3.63	2.05	4.52	7.61
Sludge Volume	m^3/d	952	1,878	705	605	342	753	1268
Sludge Concentration	%	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Note 1)SBR: Sequencing batch reactor process
2)OD: Oxidation ditch process
3)Solids= Design Flow×(Design Water Quality(SS)－Effluent Water Quality(SS))× Solids generation rate
4) Sludge Volume= Solids/(100- Sludge Concentration)

(2) Unit Processes According to Purpose

Unit processes corresponding to the purpose of sludge treatment are generally as follows, and these processes are combined. **Figure 6-2-2** shows a typical sludge process.

Volume reduction: Thickening, dewatering, drying

Reduction of solids: Digestion, incineration, melting

Qualitative stabilization: Anaerobic digestion, composting, incineration. Melting, carbonization, fuel conversion

Technical considerations in selecting processes are as follows.

a) Sludge thickening

Sludge thickening is important for thickening low-concentration sludge generated in sewage treatment facilities and thereby facilitating efficient digestion and dewatering treatment in later processes, however, the thickening properties of sludge sometimes decline due to changes in the properties of sludge. Particularly during the summer, when water temperatures increase, sludge tends to putrefy and become less suitable for thickening. Methods for thickening excess sludge, which is less conducive to thickening, consist of mechanical methods such as centrifugal thickening, atmospheric pressure flotation thickening and belt filtration thickening, etc., however, ample examination is required because such methods entail higher power costs and so on.

In order to reduce the capacity of the following processes, sewage sludge thickening tanks shall be installed at each STP.

b) Digestion

It is necessary to conduct appropriate maintenance of sludge digestion tanks and thereby improve the digestion rate in order to facilitate the generation of digestion gases for heating fuel and power generating fuel, etc. and ensure the effective utilization of digestion gases. In order to ensure efficient digestion, it is desirable to insert highly concentrated sludge into the digestion tank.

In consideration of the reduction of final disposal quantity, safety and odor of the final disposed sludge, effective utilization of digestion gas for countering global warming and so on, facilities will be installed in the Project.

c) Sludge dewatering

The sewage sludge dewatering process is important for reducing the volume of sludge for final disposal through removing water content. Previously, vacuum filters and other dewatering machines that used inorganic coagulants were used a lot. However, due to increasing demands to limit the quantity of dewatered sludge accompanying chemical injection, to make maintenance easier, to reduce water content further and to increase the solids recovery rate, combined with the development of new organic coagulants, more and more dewatering machines such as centrifugal machines, etc. that use organic coagulants are being adopted. In future there will be increasing need for the development of equipment that is geared to sludge quantity reduction, greater calorific value and energy saving, is economic and easy to maintain, as well as the development of more efficient coagulants.

Dewatering facilities will be installed in order to reduce the final disposal quantity and cut maintenance costs.

d) Sludge incineration

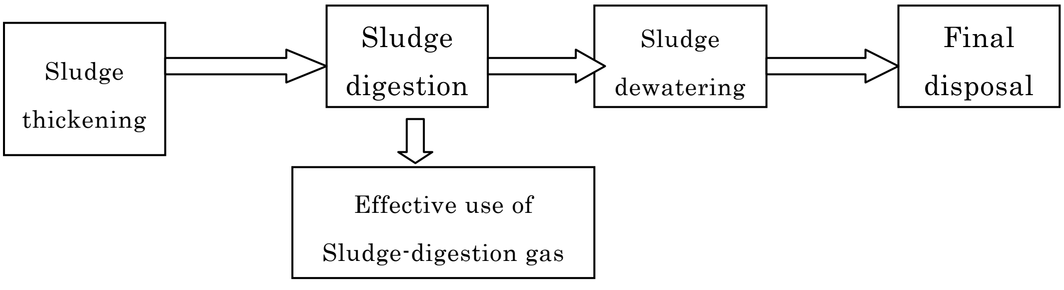
As incineration systems, the flow incinerators account for the majority due to changes in the properties of dewatered sludge and the need to limit odor, utilize waste heat and recycle incineration ash, etc. Also, the waste heat contained in exhaust gases is collected with a view to saving on fuel, and this is used for preheating combustion air and drying dewatered sludge, etc. However, because of high capital cost, difficult operation and maintenance, the sludge incineration process for dewatering would not be recommended for this project. Incineration is currently prohibited in the Philippines.

e) Sludge melting

Sludge melting has been developed as a technology for reducing the volume of sludge, preventing secondary pollution on landfill sites and recycling. Sludge melting can either entail direct melting of dewatered sludge or melting of incineration ash. The molten slag can be recycled for use as a roadbed material or in interlocking blocks and other construction materials. But at this moment this process deems too early to introduce in Philippines.

(3) Selection of the Sludge Treatment Method

As the sludge treatment method, the following combination of unit processes is proposed with emphasis placed on the form of final disposal, the effective use of energy for realization of a low-carbon society, reduction of sludge volume and safety of sludge handling.



(4) Sludge Thickening Equipment

The tank capacity is determined upon taking the following items into consideration:

- Solids load is assumed to be around 60kg/ds/(m^2/day).
- Effective water depth is assumed to be 4 m.
- In order to prevent sludge from flowing out of the tank, it is desirable to hold the sludge interface inside the tank to around 2 m below the water surface.
  Meanwhile, in order to thicken the sludge, appropriate sludge retention time inside the tank is required, and for that purpose it is necessary to give thickness to the sludge layer. If the sludge retention time inside the tank is too long, the sludge will putrefy and float to the surface in the summer months. Accordingly, retention time is generally kept to around 12 hours. For this reason, when the solids load is between 60～90kg/ds/(m^2/day) and the inserted sludge has water content of 99%, assuming the effective water depth of the tank is around 4m, retention time of around 12 hours can be obtained.
- The number of tanks as a rule is two or more.
  Since it is necessary to empty tanks in order to inspect equipment and so on, at least two tanks are installed.
- Thickened sludge concentration: This will be 2.5% because thickening performance declines in the case of excess sludge (water content 97.5%)
- Solids collection rate: This will be 85% based on actual performance, etc. in Japan.

The thickening tank shall be of circle type, that is, gravity thickening type. by the reasons mentioned here under. The functioning of the cylindrical type will be enough to achieve the total purposes for sewage sludge thickening.

- Construction costs are cheap.
- Maintenance costs are cheap.
- There are few instruments and maintenance is easy.
- There is hardly any noise or vibration.

(5) Sludge Digestion System

Sludge digestion equipment is installed with the objectives of reducing volume in later process facilities, stabilizing sludge so that it is ready for final disposal and making effective use of energy.

a) Digestion system

Since the sequencing batch reactor process and oxidation ditch process will be adopted in the Project, all sludge will be excess sludge and it will have high viscosity. It is planned to thicken this sludge before putting it into the digestion tank. Since it will be difficult to conduct solid-liquid separation with this sludge, a two-stage digester system in which the second digester conducts solids-liquid separation will not be effective. Accordingly, in consideration of economy, the anaerobic single digester will be adopted.

b) Shape and number of units

Cylindrical digestion tanks, which are extensively proven and have good economy, are proposed.

c) Stirring method

In the Project, mechanical stirring (draft tube system) that can efficiently deal with the properties of the inserted sludge is proposed.

d) Heating method

The system will basically be unheated. In these case where a generator is installed with a view to effectively utilizing gas, since generating efficiency increases if heating is conducted and the generated quantity of gas is kept uniform, it is desirable to use the indirect heating method (using heat exchanger), which utilizes waste heat from the generator to heat the digestion tank.

e) Heating system

As the gas tank structure, the dry type (low-pressure), which is easy to handle and is widely proven in treatment plants, is proposed.

(6) Sludge Dewatering Equipment

As was mentioned earlier, an important issue from the viewpoint of economic operation of the sewage utility is to select the sewage sludge dewatering method that is appropriate to the state of treated sludge.

Concerning the sludge dewatering equipment, as a result of conducting the following examination on applicable equipment as shown in **Figure 6-2-5**, specifically the centrifugal dewatering, pressure insertion screw press dewatering machine, rotating pressurized dewatering machine, belt press dewatering machine and dry bed, in consideration of economy and site issues, etc., it has been decided to propose the insertion screw press dewatering machine in the Project.

a) Examination conditions

The conditions for examining the dewatering method are indicated below. The following five sludge treatment methods are targeted. Moreover, regarding the target sludge, two cases, i.e. thickened sludge and digested sludge, are examined.

(a) Design influent sewage flow: 266,700 m^3/day (sanitary sewage discharged in the entire Project target area)

(b) Influent design SS: 225mg/L (consider influent quality of 200 mg/L and the load of return water)

(c) Discharge design water quality: 30mg/L

(d) Water treatment method: Sequencing batch reactor process or oxidation ditch process

(e) Properties of inserted sludge: Thickened sludge, anaerobic digested sludge

(f) Inserted sludge: The generated amount of sludge shall be according to the following calculation in reference to **Table 8-2-10**.

- Generated Sludge

Solids：39.02 t /day Sludge Volume：6503 m^3/day Sludge Concentration：0.6％

- Thickened sludge

Thickened sludge is calculated using the following expression:

Ts1= S r×Ts×Sc1＝39.02×0.85＝33.17 t/day

Where,

Ts1: Thickened solids(t/day)

Ts: Generated sludge(t/day)

Sc1: Solids capture rate 85% (assuming gravity thickening)

Vs1=Ts1×100/Sc=33.17×100/2.5=1327 m^3/day

Where,

Vs1: Thickened sludge volume (m^3/day)

Sc2: Sludge concentration 2.5 %

- Digested sludge（sludge inserted into the dewatering equipment）

Digested sludge is calculated using the following expression:

Ts2=Ts1×R×Sc2＝33.17×0.6×1.00 = 19.90 t/day

Where,

s2: Digested solids (t/day)

Ts1: Thickened solids (t/day)

R: Sludge generation rate 0.6 (assuming 40% of inserted solids is gasified)

Sc2: Solids capture rate 100％ (single-stage digestion with no separated liquid discharge)

Vs2(Digested sludge volume)= Thickened sludge volume=1327 m^3/day

Sc3=Ts2×100/Vs2=19.90×100/1327=1.5%

- Sludge cake(when treating thickened sludge)

Sludge cake is calculated using the following expression:

$Ts3\text{-}1=Ts1\times Sc3=33.17\times 0.95=31.51$ t/day

Where,

Ts3-1: Sludge cake solids (t/day)

Ts1: Thickened solids (t/day)

Sc3:Solids capture rate 95%

$Vs3\text{-}1=Ts3\text{-}1\times 100/Sc3\text{-}1=31.51\times 100/22=143m^3$/day

Where,

Vs1: Thickened sludge volume (m^3/day)

Sc3-1: Sludge concentration 22 % (Cake Water Concentration:78%)

- Sludge cake(when treating digested sludge)

Sludge cake is calculated using the following expression:

$Ts3\text{-}2=Ts2\times Sc3=19.90\times 0.95=18.91$ t/day

Where,

Ts3-2: Sludge cake solids (t/day)

Ts2: Digested solids (t/day)

Sc3: Solids capture rate 95%

$Vs3\text{-}2=Ts3\text{-}2\times 100/Sc3\text{-}2=18.91\times 100/18=105\ m^3$/day

Where,

Vs1: Thickened sludge volume (m^3/day)

Sc3-1: Sludge concentration 18 % (Cake Water Concentration:82%)

(g) Operating time

- Dewatering machine operating time: 16 hours/day (2-person operation, day and night 2-shifts), 240 days/year
- Machine operating rate: 80%
- Stoppage for machine maintenance: Do not consider (because it will be conducted on national holidays and Saturdays and Sundays).

b) List of Equipment in Target Facilities

Rough capacity calculation of facilities was conducted and comparison of economy was implemented based on the above conditions. **Table 8-2-11** shows a comparison of equipment lists between the case of treating thickened sludge and the case of treating digested sludge.

Table 8-2-11 Comparison of Dewatering Facilities

Items	unit	Centrifugal Dewatering Machine Type		Pressuer Insention Screw Press Dewatering Machine type		Rotating pressurized Dewatering Machine type		Belt Press Dewatering Machine type		Sludge Drying Bed	
		Thickened sludge case	Digested sludge case	Thickened sludge case	Digested sludge case	Thickened sludge case	Digested sludge case	Thickened sludge case	Digested sludge case	Thickened sludge case	Digested sludge case
1.Sludge Dewatering Equipment											
1)Sludge Dewatering Machine											
Treatment Capacity	m^3/hr	30	30								
Screen Diameter	mm			1100	1100						
Filter Diameter	mm					1200	1200				
Channels	ch					4	4				
Filtration area	m^2					6	6				
Filter cloth width	m							3.00	3.00		
Motor Output	kW	148	148	10	10	13.2	13.2	8.2	8.20		
Number of Units	units	6	6	6	6	9	6	11	12.00		
Width	m									20.0	20.0
Length	m									40.0	40.0
Water depth	m									0.2	0.2
Number of tanks:	sets									166	165
Sludge drying bed area	m^2									132,800	132000
2)Sludge Feed Pump											
Type of Pump		Unaxial screw pump									
Bore diameter	mm	φ150	φ150	φ150	φ150	φ100	φ150	φ100	φ100		
Discharge rate	m^3/min	0.50	0.5	0.5	0.5	0.3	0.5	0.4	0.3		
Total Head	m	20.0	20	20	20	20	20	20	20		
Motor Output	kW	15.0	15	15	15	11	15	11	11		
Number of punps	units	7(1)	7(1)	7(1)	7(1)	10(1)	7(1)	12(1)	13(1)		
3)Chemical-dosage	kg/d	654	392	604	422	654	392	654	392		
4)Chemical solution tank											
Type of tank		Steel cylinder tank									
Capacity	m3	9	6	9	6	6	6	6	6		
Mixing power	kW	5.5	3.7	5.5	3.7	3.7	3.7	5.5	3.7		
Number of tank	units	6	6	6	6	9	6	11	6		
5)Chemical feed pump											
Type of Pump		Unaxial screw pump									
Bore diameter	mm	50	50	50	50	50	50	50	50		
Discharge rate	m^3/min	0.04～0.12	0.02～0.07	0.04～0.11	0.02～0.07	0.03～0.10	0.05～0.16	0.04～0.12	0.02～0.07		
Total head	m	20	20	20	20	20	20	20	20		
Motor Output	kW	3.7	2.2	3.7	2.2	3.7	5.5	3.7	2.2		
Number of punps	台	7(1)	7(1)	7(1)	7(1)	10(1)	7(1)	12(1)	13(1)		
5)Chemical feeder											
Type		Positive displacement piece feeder									
Feed rate	L/min	1.5～3	1～2	1.5～3	1～2	1.5～3	1～2	1.5～3	1～2		
Storage discharge	L	100	100	100	100	100	100	100	100		
Motor Output	kW	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4		
Number of feeder	台	6	6	6	6	9	6	11	6		
2.Cake storage hopper											
Type of hopper		Electric cut gate									
Capacity	m3	12	12	12	12	12	12	12	12		
Motor Output	kw	3	3	3	3	3	3	3	3		
Number of hopper	units	13	9	13	9	13	9	13	9		

c) Comparison of dewatering equipment

As is shown in **Table 8-2-11**, an extensive area of 13 ha is required for dry beds. Moreover, since measures will be needed to counter secondary pollution such as odor and flies, etc. and the dewatering capacity declines during the humid rainy season, this method will not be adopted in the Project. Therefore, mechanical dewatering methods will be targeted in the subsequent examination.

Table 8-2-12 shows each of the aforementioned sludge dewatering methods. Moreover, **Tables 8-2-13** through **8-2-16** show the basis for determining economy.

The high-efficiency centrifugal dewatering machine needs to be taken to the factory for time-consuming work when repairs are necessary, so dewatering capacity deteriorates during this period. Moreover, in economic terms too, it is not suited to the Project because the capacity of electrical equipment is large and maintenance costs are high. The rotating pressurized dewatering machine is the most expensive equipment; moreover, its performance in treating sludge has not been sufficiently proven, so this too isn’t suited to the Project. As for the belt press dewatering machine, since 12 units would be required in the Project, large-size units cannot be installed and it would be difficult to install many units in the event of expanding capacity, this too isn’t appropriate. On the other hand, the pressure insertion screw press dewatering machine is economical and entails easy maintenance irrespective of whether dewatering thickened sludge or digested sludge.

Therefore, in consideration of economy and ease of maintenance, **the pressure insertion screw press dewatering machine is proposed** as the dewatering method for the Project, in both the case of treating thickened sludge and the case of treating digested sludge.

Table 8-2-12 Comparison of Sludge Dewatering Systems

Item	High-efficiency centrifugal dewatering machine	Pressure insertion screw press dewatering machine	Rotating pressurized dewatering machine	Belt press dewatering machine
1) Outline structure	Coagulated sludge is fed into a high speed rotating cylindrical bowl, where it is subjected to 1,000~2,000 G centrifugal force that causes solids-liquid separation.	Coagulated sludge is fed between the continuously rotating cylindrical screen and conical screw, and water is pressed out.	Coagulated sludge is fed between two rotating disc filters and spacer, and water is pressed out.	Coagulated sludge undergoes pressure filtration on continuously running filter cloth, and water is squeezed between two rollers.
2) Used coagulant	Organic coagulant is used, but this is sometimes used in combination with inorganic coagulant.	Ditto	Ditto	Ditto
3) Dewatering performance	Dewatering performance is influenced by the sludge properties and operating conditions (centrifugal force, differential rate, chemical dosing rate). Performance indicators are the dewatered sludge water content, treated quantity and SS recovery rate.	Dewatering performance is influenced by the sludge properties and operating conditions (screw rpm, sludge feed pressure, chemical dosing rate). Performance indicators are the dewatered sludge water content, filtration speed and SS recovery rate.	Dewatering performance is influenced by the sludge properties and operating conditions (filter rpm, outlet pressure, chemical dosing rate). Performance indicators are the dewatered sludge water content, filtration speed and SS recovery rate.	Dewatering performance is influenced by the sludge properties and operating conditions (filter cloth running speed, filter cloth tension, chemical dosing rate). Performance indicators are the dewatered sludge water content, filtration speed and SS recovery rate.
4) Maintenance	- There are fewer auxiliary devices than in the belt press dewatering machine so maintenance is easy. - Operating factors are the amount of fed sludge, chemical dosing rate, centrifugal force and differential rate.	- Structure is simple and maintenance is easy. - Operating factors are the amount of fed sludge, sludge feed pressure, chemical dosing rate and screw rpm.	- Structure is simple and maintenance is easy. - Operating factors are the amount of fed sludge, sludge feed pressure, chemical dosing rate, filter rpm and outlet pressure.	- There are few auxiliary devices so structure is simple and maintenance is easy. - Operating factors are the amount of fed sludge, chemical dosing rate, filter cloth running speed and filter cloth tension.
5) Equipment area	- There are few auxiliary devices so installation area is small. - Treatment capacity in the best machines is 80 m3/h and more space can be saved as the treatment quantity increases.	- The dewatering machine unit is compact so installation area is small. - Screen diameter per machine is 200~1,200 mm.	- The dewatering machine unit is compact so installation area is small. - Diameter of metal disc filters in each machine is 600~1,200 mm.	- There are few auxiliary devices so installation area is small. - Width of filter cloth in each machine is 0.5~3.0 m.
6) Merits	* It has a good track record. - Automatic operation is easy. - Large-scale treatment is possible. - There are no blockages. - There is no need for washing. - Structure is closed. * The SS recovery rate is high.	* Energy saving * There is little noise * There is little washing water	* Energy saving * Equipment is lightweight. - Installation space is small. * There is little noise * It is airtight. * There is little washing water	* It has a good track record. * There is little noise * The SS recovery rate is high.
7) Demerits	* Motor is large. * Screw repairs are needed. * There is much noise.	* Track record is limited. * SS recovery rate is low. * Outer cylinder washing is necessary.	* Track record is limited.	* Filter cloth replacement is needed. * Equipment is subject to corrosion. * Filter cloth has to be washed. * Odor countermeasures are difficult. * There are numerous auxiliary instruments. * Equipment is heavy.
8) Properties of applicable sludge	* Large-scale treatment * Mixed raw sludge * Digested sludge * OD sludge * Sludge that is not conducive to dewatering and is unsuited to filtration machines	* Mixed raw sludge * Digested sludge * OD sludge	* Mixed raw sludge * OD sludge	* Mixed raw sludge * Digested sludge * OD sludge *Since the equipment comprises high precision and fast rotating instruments, there may be cases where repairs need to be conducted in the plant.
9）経済性	Thickened sludge case 2,040,,000,000peso Digested sludge case 1,468,000,000peso	Thickened sludge case 1,532,,000,000peso Digested sludge case 1,449,000,000peso	Thickened sludge case 2,549,000,000peso Digested sludge case 1,952,000,000peso	Thickened sludge case 1,672,000,000peso Digested sludge case 1,558,000,000peso
9)Overall evaluation	3	3	2	1

Note: The numbers in the last column means superiority orders (smaller number is better than larger.

Table 8-2-13 Economic Basis of Dewatering Machine (when dewatering thickened sludge)

	High-efficiency Centrifugal Dewatering Machine Type				Pressuer Insention Screw Press Dewatering Machine type				Rotating pressurized Dewatering Machine type				Belt Press Dewatering Machine type			
Design Flow			266,700	m3/d			266,700	m3/ d			266,700	m3/ d			266,700	m3/ d
Design Sludge Volume			1,327	m3/d			1,327	m3/ d			1,327	m3/ d			1,327	m3/ d
Design Solids			33.17	t/d			33.17	t / d			33.17	t / d			33.17	t / d
Equipment cost	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total
Sludge feed pump	Unaxial screw pump φ150mm×0.50m3/min×15.0kw				Unaxial screw pump φ150mm×0.50m3/min×15.0kw				Unaxial screw pump φ100mm×0.30m3/min×11.0kw				Unaxial screw pump φ100mm×0.40m3/min×11.0kw			
	2,156,500	7		15,095,500	2,156,500	7		15,095,500	2,156,500	10		15,095,500	2,156,500	12		15,095,500
Dewatering Equipment	30m3/hr×148.0kw				φ1100mm×10.0kw				φ1200mm×4ch×13.2kw				Filter cloth width 3.0m×8.2kw			
	16,850,000	6		101,100,000	27,950,000	6		167,700,000	66,000,000	9		594,000,000	15,500,000	11		170,500,000
Chemical solution tank	Steel cylinder tank 9m3×5.5kw				Steel cylinder tank 9m3×5.5kw				Steel cylinder tank 6m3×3.7kw				Steel cylinder tank 6m3×5.5kw			
	2,803,500	6		16,821,000	2,803,500	6		16,821,000	2,803,500	9		25,231,500	2,803,500	11		30,838,500
Chemical feed pump	Unaxial screw pump φ50mm×3.7kw				Unaxial screw pump φ50mm×3.7kw				Unaxial screw pump φ50mm×3.7kw				Unaxial screw pump φ50mm×3.7kw			
	640,500	7		4,483,500	640,500	7		4,483,500	640,500	10		6,405,000	638,500	12		7,662,000
Chemical feeder	Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 2.0L/min×100L×0.4kw			
	2,399,000	6		14,394,000	2,399,000	6		14,394,000	2,399,000	9		21,591,000	2,399,000	11		26,389,000
Cake storage hopper	Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw			
	9,105,000	13		118,365,000	9,105,000	13		118,365,000	9,105,000	13		118,365,000	9,105,000	13		118,365,000
Equipment cost total				270,259,000				336,859,000				780,688,000				368,850,000
Piping-installation cost	It assumes 50 % of the equipment cost.				It assumes 50 % of the equipment cost.				It assumes 50 % of the equipment cost.				It assumes 50 % of the equipment cost.			
	270,259,000	0.5		135,129,500	336,859,000	0.5		168,429,500	780,688,000	0.5		390,344,000	368,850,000	0.5		184,425,000
Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.				It assumes 40 % of the equipment cost and piping-installation cost.				It assumes 40 % of the equipment cost and piping-installation cost.				It assumes 40 % of the equipment cost and piping-installation cost.			
	405,388,500	0.4		162,155,400	505,288,500	0.4		202,115,400	1,171,032,000	0.4		468,412,800	553,275,000	0.4		221,310,000
Operation and maintenance cost																
	147,183,200	10		1,471,832,000	82,977,310	10		829,773,100	91,494,320	10		914,943,200	90,290,033	10		902,900,333
Cost of Equipment																
				2,039,375,900				1,537,177,000				2,554,388,000				1,677,485,333
Sludge drying bed area																
Site area																

Table 8-2-14 Basis for Calculating Dewatering Machine Maintenance Cost (when dewatering thickened sludge)

	High-efficiency Centrifugal Dewatering Machine Type				Pressuer Insention Screw Press Dewatering Machine type				Rotating pressurized Dewatering Machine type				Belt Press Dewatering Machine type			
	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	人	960,000	240,000	4	人	960,000	240,000	4	人	960,000	240,000	4	人	960,000
②Electricity Rate																
Electric capacity																
Sludge feed pump	15	6	90		15	6	90		15	9	135		15	11	165	
Dewatering Equipment	148	6	888		10	6	60		13.2	9	118.8		8.2	11	90.2	
Chemical solution tank	5.5	6	33		3.7	6	22.2		3.7	9	33.3		3.7	11	40.7	
Chemical feed pump	3.7	6	22.2		2.2	6	13.2		5.5	9	49.5		2.2	11	24.2	
Chemical feeder	0.4	6	2.4		0.4	6	2.4		0.4	9	3.6		0.4	11	4.4	
Cake storage hopper	3	13	39		3	13	39		3	13	39		3	13	39	
			1074.6				226.8				379.2				363.5	
	1074.6kw×0.7×12.8hr×240day				226.8kw×0.7×12.8hr×240day				379.2kw×0.7×12.8hr×240day				363.5kw×0.7×12.8hr×240day			
			2,310,820				487,711				815,432				781,670	
Electricity Rate(peso/yrs)	10	2,310,820		23,108,200	10	487,711		4,877,110	10	815,432		8,154,320	10	781,670		7,816,700
③Chemical-dosage cost	654kg/d×365days=		238710		422kg/d×365days=		154030		392kg/d×365days=		143080		392kg/d×365days=		143080	
	500	238710		119,355,000	500	154030		77,015,000	500	143080		71,540,000	500	143080		71,540,000
④Rework Cost(peso/yr)	626,667	6		3,760,000	20,867	6		125,200	1,204,444	9		10,840,000	906,667	11		9,973,333
Total operation and maintenance cost				147,183,200				82,977,310				91,494,320				90,290,033

Table 8-2-15 Economic Basis of Dewatering Machine (when dewatering digested sludge)

	High-efficiency Centrifugal Dewatering Machine Type				Pressuer Insention Screw Press Dewatering Machine type				Rotating pressurized Dewatering Machine type				Belt Press Dewatering Machine type			
Design Flow			266,700	m3/d			266,700	m3/ d			266,700	m3/ d			266,700	m3/ d
Design Sludge Volume			1,327	m3/d			1,327	m3/ d			1,327	m3/ d			1,327	m3/ d
Design Solids			19.9	t/d			19.90	t / d			19.90	t / d			20	t / d
Equipment cost	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total
Sludge feed pump	Unaxial screw pump φ150mm×0.50m3/min×15.0kw				Unaxial screw pump φ150mm×0.50m3/min×15.0kw				Unaxial screw pump φ150mm×0.50m3/min×15.0kw				Unaxial screw pump φ150mm×0.50m3/min×15.0kw			
	2,156,500	7		15,095,500	2,156,500	7		15,095,500	2,156,500	7		15,095,500	2,156,500	7		15,095,500
Dewatering Equipment	30m3/hr×148.0kw				φ1100mm×10.0kw				φ1200mm×4ch×13.2kw				Filter cloth width 3.0m×8.2kw			
	16,850,000	6		101,100,000	27,950,000	6		167,700,000	66,000,000	6		396,000,000	15,500,000	12		186,000,000
Chemical solution tank	Steel cylinder tank 6m3×3.7kw				Steel cylinder tank 6m3×3.7kw				Steel cylinder tank 6m3×3.7kw				Steel cylinder tank 6m3×3.7kw			
	2,803,500	6		16,821,000	2,803,500	6		16,821,000	2,803,500	6		16,821,000	2,803,500	6		16,821,000
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw				Unaxial screw pump φ50mm×2.2kw				Unaxial screw pump φ50mm×5.5kw				Unaxial screw pump φ50mm×2.2kw			
	640,500	5		3,202,500	640,500	5		3,202,500	640,500	5		3,202,500	638,500	9		5,746,500
Chemical feeder	Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 2.0L/min×100L×0.4kw			
	2,399,000	6		14,394,000	2,399,000	6		14,394,000	2,399,000	6		14,394,000	2,399,000	6		14,394,000
Cake storage hopper	Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw			
	9,105,000	9		81,945,000	9,105,000	9		81,945,000	9,105,000	9		81,945,000	9,105,000	9		81,945,000
Equipment cost total				232,558,000				299,158,000				527,458,000				320,002,000
Piping-installation cost	It assumes 50 % of the equipment cost.				It assumes 50 % of the equipment cost.				It assumes 50 % of the equipment cost.				It assumes 50 % of the equipment cost.			
	232,558,000	0.5		116,279,000	299,158,000	0.5		149,579,000	527,458,000	0.5		263,729,000	320,002,000	0.5		160,001,000
Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.				It assumes 40 % of the equipment cost and piping-installation cost.				It assumes 40 % of the equipment cost and piping-installation cost.				It assumes 40 % of the equipment cost and piping-installation cost.			
	348,837,000	0.4		139,534,800	448,737,000	0.4		179,494,800	791,187,000	0.4		316,474,800	480,003,000	0.4		192,001,200
Operation and maintenance cost																
	98,529,540	10		985,295,400	82,624,640	10		826,246,400	84,961,170	10		849,611,700	89,108,670	10		891,086,700
Cost of Equipment																
				1,473,667,200				1,454,478,200				1,957,273,500				1,563,090,900
Sludge drying bed area																
Site area																

Table 8-2-16 Basis for Calculating Dewatering Machine Maintenance Cost (when dewatering digested sludge)

	High-efficiency Centrifugal Dewatering Machine Type				Pressuer Insention Screw Press Dewatering Machine type				Rotating pressurized Dewatering Machine type				Belt Press Dewatering Machine type			
	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total	Unit price	Unit		Total
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000
②Electricity Rate																
Electric capacity																
Sludge feed pump	15	6	90		15	6	90		15	6	90		15	6	90	
Dewatering Equipment	148	6	888		10	6	60		13.2	6	79.2		8.2	12	98.4	
Chemical solution tank	3.7	6	22.2		3.7	6	22.2		3.7	6	22.2		3.7	6	22.2	
Chemical feed pump	1.5	4	6		2.2	4	8.8		5.5	4	22		2.2	12	26.4	
Chemical feeder	0.4	6	2.4		0.4	6	2.4		0.4	6	2.4		0.4	6	2.4	
Cake storage hopper	3	9	27		3	9	27		3	9	27		3	9	27	
			1035.6				210.4				242.8				266.4	
	1035.6kw×0.7×12.8hr×240day				210.4kw×0.7×12.8hr×240day				242.8kw×0.7×12.8hr×240day				266.4kw×0.7×12.8hr×240day			
			2,226,954				452,444				522,117				572,867	
Electricity Rate(peso/yrs)	10	2,226,954		22,269,540	10	452,444		4,524,440	10	522,117		5,221,170	10	572,867		5,728,670
③Chemical-dosage cost	392kg/d×365days=		143080		422kg/d×365days=		154030		392kg/d×365days=		143080		392kg/d×365days=		143080	
(peso/yr)	500	143080		71,540,000	500	154030		77,015,000	500	143080		71,540,000	500	143080		71,540,000
④Rework Cost(peso/yr)	626,667	6		3,760,000	20,867	6		125,200	1,206,667	6		7,240,000	906,667	12		10,880,000
Total operation and maintenance cost				98,529,540				82,624,640				84,961,170				89,108,670

(7) Final Disposal and Effective Utilization of Sludge

As mentioned above, there are various ways in which sludge can be put to use. In the project, dewatered sludge can be utilized on green and farmland or for landfill purposes; In this project, composting, soil melioration, and land filling as final sewage sludge treatment are recommendable. However, stock yards for dry cake and developing sales routes for the sales materials should be considered. The current final sewage sludge management by MWSI and MWCI are as follows.

a) Current Management System of Sewage sludge of MWSI

(a) Current facilities operated by MWSI are as follows.

- Dagat-Dagatan Sewage and Septage Treatment Facility
  Chemical Precipitation Process with Dewatering
  Utilizes S crew Type Press to achieve optimum moisture content for dewatered treated septage

- Alabang Sewage Treatment Plant
  Activated Sludge Treatment Process
  MWSI uses drying bed in Alabang STP. The STP also has a filter press dewaterer but they don't use it, because the dry bed has enough capacity to treat all sludge generated in the STP.

(b) Management of Septage and Sewage Sludge

MWSI uses drying bed in Alabang STP and dry cake produced by it are hauled by outside company. Current Management System of Sewage sludge

The outside company hauls sludge generated by the plant to convert the biosolids into a soil nutrient supplement that can be used for agricultural purposes, and uses "vermiculture " that utilizes cultured earthworms that feed on biosolids and produce waste products with significant reduction of metals.

Remaining dry cakes are land filled or dumped into dump sites.

b) Current Management System of Sewage sludge of MWCI

Wastewater screenings from the sewage treatment plants are disposed to landfill and the dried sludge cake produced by the plants is used by the local community as soil conditioner. Owing to the lack of industrial discharges to the sewer system, the sludges are relatively free of toxic contaminants and are suitable for this end use.

The Philippine Fertilizer and Pesticide Authority has issued a temporary license to MWCI for the use of septage sludge and dried sludge from sewage treatment plants as soil conditioners for selected crops, as well as with lahar to produce a medium that will produce commercially saleable crops.

2) Accommodation of the System Plant in Site Candidate

Figure 3-4-1(1) shows STP No(Pa2+Pb2)(attached as appendix), **Figure 3-4-1(2)** shows STP No.(Pa1+Lb1)(attached as appendix), **Figure 3-4-1(3)** shows STP No(La1)(attached as appendix), **Figure 3-4-1(4)** shows STP No.(Pc)(attached as appendix), **Figure 3-4-1(5)** shows STP No.(La2+Lb2)(attached as appendix), **Figure 3-4-1(6)** shows STP No.(Pb1)(attached as appendix), **Figure 3-4-1(7)** shows STP No.(Pd)(attached as appendix).

3) Comparison of Onsite and Offsite sewage sludge management

(1) Sewage Sludge Treatment Method

In consideration of the economy of sludge treatment, efficiency of energy collection and recycling and location conditions, etc., sludge generated at multiple treatment plants can be implemented using the on-site approach at each treatment plant or the off-site approach, in which centralized treatment is implemented.

As a result of comparing economy, etc. between the on-site approach and offsite approach, judging from Table 7-1-4-14, the offsite approach offers better merits of scale and is cheaper in both cases of treating thickened sludge and digested sludge. Furthermore, there is greater potential for utilization of digestion gas, etc. when a large quantity is collected. Accordingly, in the Project, upon giving priority to economy, since it is deemed advantageous to adopt the offsite approach with Pa2+Pb2 STP (STP location ID No.P-11) as the host treatment plant, this is proposed.

(2) Sludge transportation method in the off-site approach

The following three options centering on the pipeline transportation of liquid sludge can be considered as methods for transporting sludge in the case of the off-site approach.

a) Option 1: Plan for transferring generated sludge

This plan entails transferring the sludge generated at each treatment plant to the centralized treatment facility. **Figure 8-2-10**shows the flow. This plan has the following features.

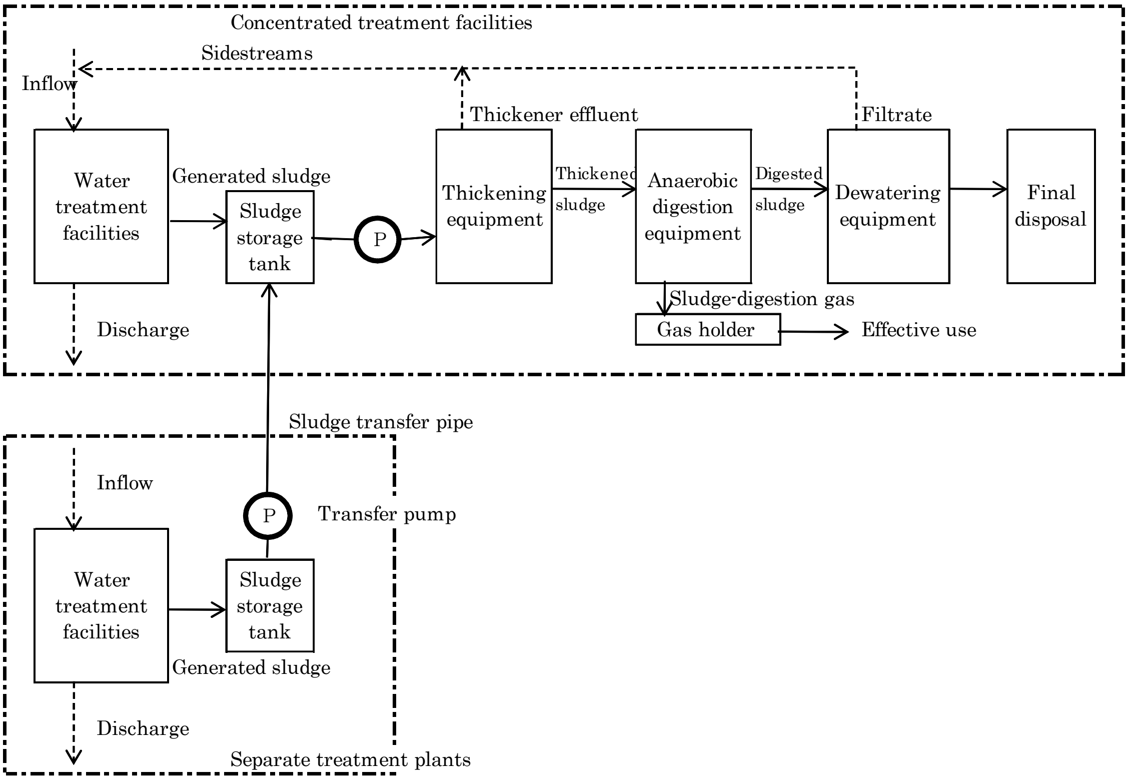
(a) Merits

- The sludge treatment processes can be totally centralized, thereby enabling maintenance to be reduced.
- Energy sources such as digested gas can be utilized fully.

(b) Demerits

- The amount of sludge transfer is the largest in this plan and the transfer costs are the most expensive.
- Return water load in the centralized treatment facility is large and the impact of this on water treatment is a concern. In some cases, it may be necessary to adopt a separate treatment facility for return water.

Figure 8-2-10 Flow of Generated Sludge Transfer



b) Option 2: Plan for transferring thickened sludge

This plan entails thickening the sludge generated at each treatment plant and transferring the thickened sludge to the centralized treatment facility. **Figure 8-2-11** shows the flow. This plan has the following features.

(a) Merits

- Since thickened sludge can be reduced to 15% of the volume of generated sludge, the costs of transfer can be reduced.
- The return water load placed on water treatment in the centralized facility can be mitigated.
- Utilization of digestion gas for energy purposes can be maximized.

(b) Demerits

- The individual treatment plants have to conduct a part of the sludge thickening treatment.

c) Option 3: Plan for transferring digested sludge

This plan entails thickening and conducting anaerobic digestion of the sludge generated at each treatment plant and transferring the digested sludge to the centralized treatment facility. **Figure 8-2-12** shows the flow. This plan has the following features.

(a) Merits

- As with thickened sludge, since digested sludge can be reduced to 15% of the volume of generated sludge, the costs of transfer can be reduced.
- The return water load placed on water treatment in the centralized facility can be mitigated.

(b) Demerits

- Most of the sludge treatment facilities except sludge thickener are installed in the individual treatment plants and there isn't much centralization.

- Utilization of digestion gas for energy purposes becomes dissipated, thereby preventing maximum utilization.

Figure 8-2-11 Flow of Thickened Sludge Transfer

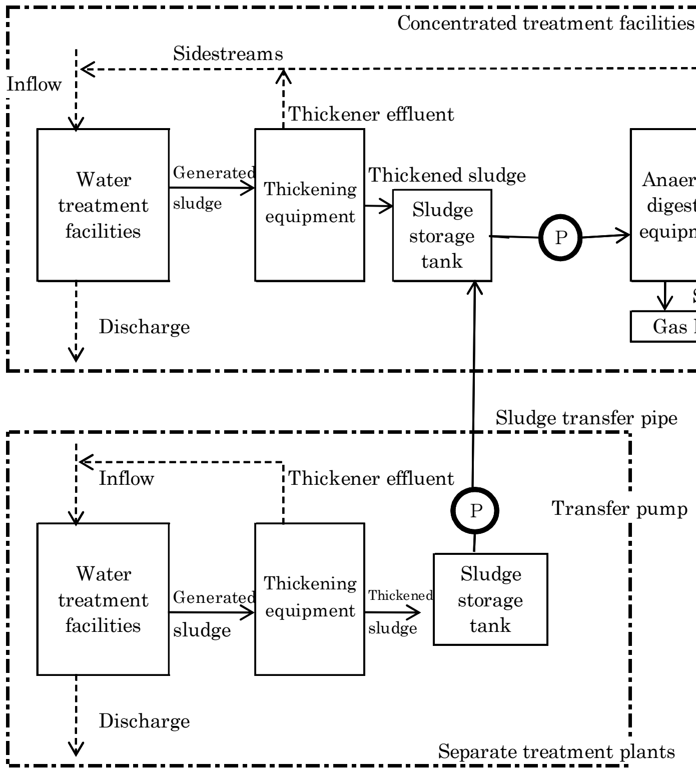
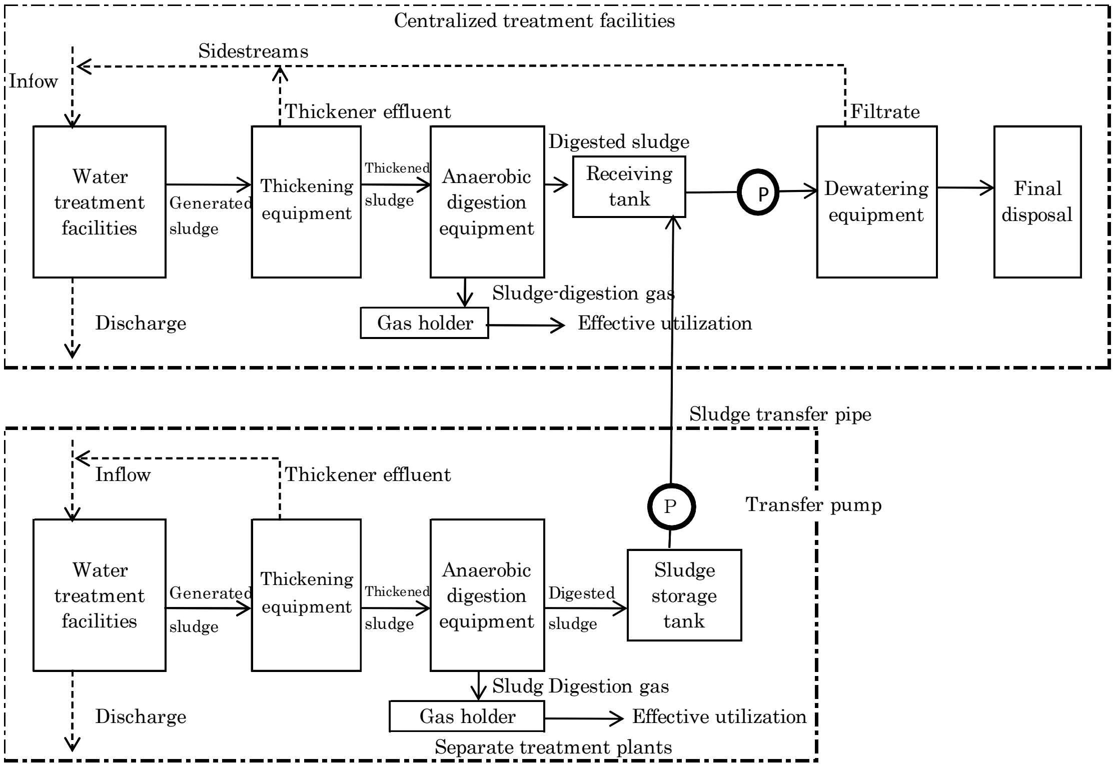


Figure 8-2-12 Flow of Digested Sludge Transfer



d) Proposal of the sludge transportation method

Table 8-2-17 shows the results of comparing sludge transportation costs upon referring to current costs. Regarding the transportation method in the case of consolidated treatment, Option 2 is deemed to be appropriate in the Project because the transportation cost is cheap, the impact on water treatment at the consolidated treatment plant is small, and digestion gases can be utilized to the fullest extent.

Therefore, as the sludge transportation method, sludge gravity thickening will be conducted at each treatment plant and the thickened sludge will be transported.

Table 8-2-17 Comparison of Transportation Costs

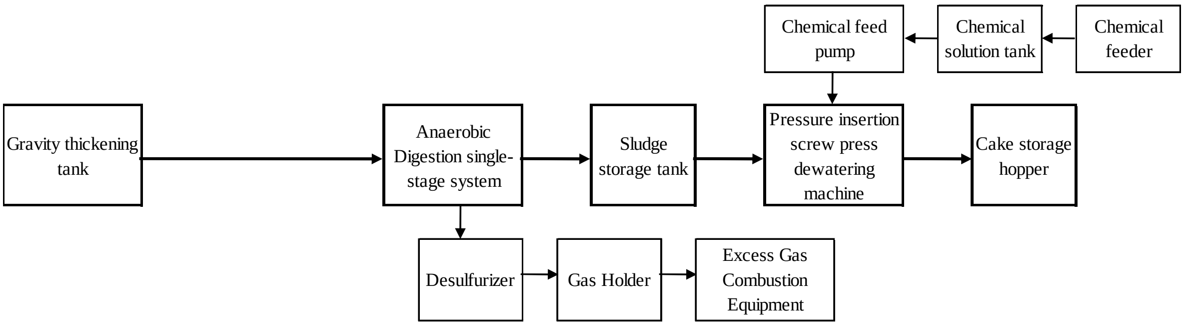
Type of sludge	Sludge quantity (m^3/day)	Unit cost (Peso/m^3)	Transportation cost (Peso/day)	Remarks
Generated Sludge	6,503	200	1,300,600	
Thickened sludge	1,327	200	265,400	
Digested sludge	1,327	200	265,400	

(3) Examination of onsite and offsite sewage sludge

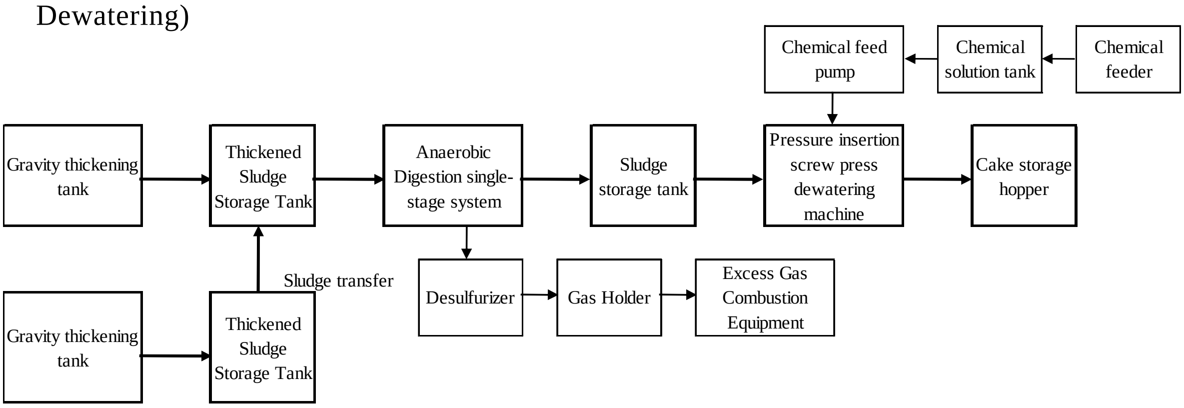
Generally, when the scale of treatment becomes large, the off-site approach enables merits of scale to be realized and is thus more advantageous in terms of construction cost and maintenance cost. In particular, personnel expenses in maintenance can be greatly saved on. Moreover, recyclable energy such as digestion gas, etc. is concentrated together and can be effectively utilized more efficiently.

Below, rough capacity calculation is carried out with a view to comparing economy between the onsite approach and offsite approach. The comparison is conducted for the following cases concerning the sludge treatment method.

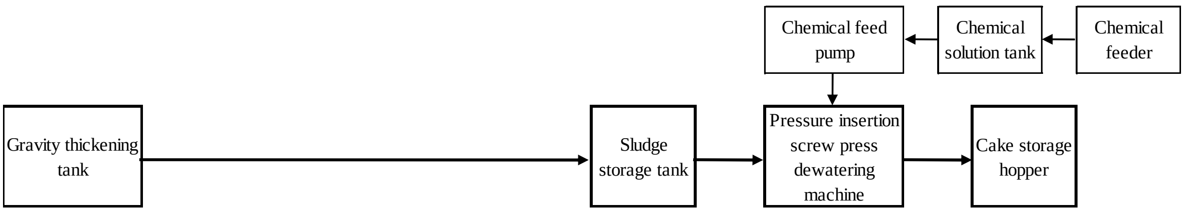
CASE1: On-site1(Unit Processes according to Purpose: Sludge Thickening-Digestion-Sludge Dewatering)



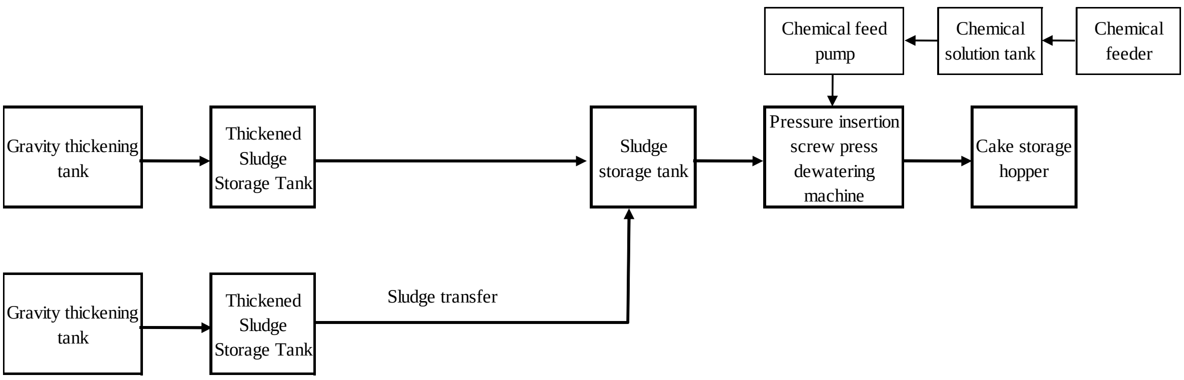
CASE2: Off-site1(Unit Processes according to Purpose: Sludge Thickening-Digestion-Sludge Dewatering)



CASE3: On-site2(Unit Processes according to Purpose: Sludge Thickening-Sludge Dewatering)



CASE4: Off-site2(Unit Processes according to Purpose: Sludge Thickening-Sludge Dewatering)



a) Examination conditions

The comparison of treatment cost and transportation cost between the onsite and offsite methods of sludge treatment is based on the following conditions.

(a) Operating time and transportation time

- Sludge transportation time: 08:00 to 17:00 (including 1 hour for lunch break)
- Sludge transportation days: Weekdays not including national holidays and Saturdays

and Sundays (240 days/year)

- Dewatering machine operating time: 16 hours/day (2-person operation, day and night –shifts)
- Machine operating rate: 80%
- Stoppage for machine maintenance: Do not consider (because it will be conducted on national holidays and Saturdays and Sundays).

(b) Cost comparison

(b)-1 On-site treatment

- Operating personnel expenses (Op)
  Op = 4 persons × 20,000 peso/mo = 80,000peo/mo
- Thickened sludge transportation cost (Ts: peso/day)
- Thickened sludge storage tank and digested sludge storage tank capacity and dewatering machine capacity.
  - ✧ Thickened sludge storage tank: The necessary storage period shall be 3 days based on the dewatering machine operating time.
  - ✧ Digested sludge storage tank: The necessary storage period shall be 3 days based on the dewatering machine operating time.
  - ✧ Dewatering machine capacity: This will be calculated assuming the dewatering process operation time.
    Total operating time: Ot= 16 hour×80% = 12.8 hour/day
    Daily sludge treatment quantity: Dc1=Dc × 240day/365day
    Hourly sludge treatment quantity: Dc2=Dc1 × 24hr/12.8hr
    Treated quantity per unit: Dce=Dc2/Mn
    Where:
    Dc: Thickened sludge or digested sludge solid quantity (kg/day)
    Dce: Treated quantity per unit (kg/hr)
    Mn: Number of units installed

- Incineration equipment, digestion gas tank
  - ✧ Incineration equipment: The generated amount of digestion gas shall be the incineration capacity.
  - ✧ Digestion gas tank: The tank shall have enough capacity to hold 12 hours of generated digestion gas.
- Sludge equipment running costs
  - ✧ Running cost apart from the dewatering machines: Rm
    Total equipment electrical capacity x Operating rate x 10 peso (electricity tariff 10 peso/kWh)
    Operating rate: Assumed to be 0.7
  - ✧ Dewatering machine running cost: Rd
    Total dewatering machine electrical capacity x Efficiency x 12.8 hours x 10 peso
    Efficiency: Assumed to be 0.7
- Total sludge treatment cost for use in price comparison
  - ✧ Operation and transportation costs (personnel expenses + transportation cost + running cost) = 80,000＋Ts＋Rm＋Rd
  - ✧ Total equipment cost = Total equipment cost at each treatment plant

(b)-2 Offsite treatments

- Thickened sludge transportation cost: Thickened sludge is transported to the host treatment plant by vacuum truck
- Preconditions
  - ✧ Vacuum truck: 10 ton truck
  - ✧ Transportation cost: 200 peso/m^3 (current cost)
  - ✧ Transportation speed: 10 km/h (due to congestion)
  - ✧ Operating time: 8 hours
- Average transportation distance: Td (km)

The combined distance from each franchise treatment plant to the host treatment plant divided by the number of franchise treatment plants

- Average transportation time (one-way): Tt(hour)
  Tt＝Td/10km
- Sludge loading time : Stt（hour）
  Stt＝0.5 hour
- Average transportation round-trip number of times in the workday: Rt (volta)
  Rt＝workday（8hour）/{2×(Tt＋Stt)}
- Total transportation sludge quantity: Fts (m^3/day)
  This is the total amount of thickened sludge generated from the franchise treatment plants.
- Necessary motor lorry number: Vcn (set)
  Vcn= Fts/(10 t×Rt)
- Total transportation cost: Ttc(peso)
  Ttc=Fts×200peso
- Other costs: This is calculated by the same method used for offsite treatment.
- The total sludge treatment cost used in price comparison
  - ✧ Operation and transportation costs (personnel expenses + transportation cost + running cost) =80,000+Ttc+Rm+Rd
  - ✧ Total equipment cost = Total equipment cost at each treatment plant

b) Selection of the host treatment plant in the case offsite treatment

In the Project, the following seven treatment plants are proposed, i.e. Pa1+Lb1 STP, Pa2+Pb2 STP, Pb1 STP, Pc STP, Pd+Pe STP, La1 STP and La2+Ld2 STP. Since sludge will be generated and will need to be treated from the start, it is appropriate to select a plant that is constructed in the first phase and has plenty of site space as the host treatment plant. Pa2+Pb2 STP is proposed for construction in Phase 1, it has the best developed site of all seven candidate sites, the surrounding road is in place (meaning that there will be n problem in carrying in thickened sludge and removing sludge cake), and the site is large. Accordingly, this site is recommended as the best option in the Project.

c) Calculation of thickened sludge and sludge cake transportation costs

The thickened sludge and sludge cake transportation costs are calculated using the previously indicated expression.

(a) Thickened sludge transportation cost

- Average materials handling distance: Td = 4.5 km

Table 8-2-18 shows the transportation distances from the franchise treatment plants to the host treatment plant (Pa2+Pb2 STP) and the average transportation distance.

Table 8-2-18 Transportation Distances from Each Franchise Treatment Plant

	(Pa1+Lb1) to (Pa2+Pb2)	Pb1 to (Pa2+Pb2)	Pc to (Pa2+Pb2)	(Pd+Le) to (Pa2+Pb2)	La1 to (La2+Pb2)	(La2+Lb2) to (Pa2+Pb2)
Materials handling distance	7.1	5.4	3.3	5.1	5.1	1.2
Average materials handling distance	4.5(Td)					

- Average transportation time(one way):Tt(hour)
  Tt=Td/10=4.5/10=0.5 hour
- Sludge loading time : Stt=0.5 hour
- Average transportation round-trip number of times in the workday: Rt (volta)
  Rt＝workday（8hour）/{2×(Td＋Stt)} ＝8/(2×(0.5＋0.5)=4 volta
- Total transportation sludge quantity: Fts (m^3/day)

Table 8-2-19 shows the total amount of thickened sludge generated from the franchise treatment plants.

Table 8-2-19 Total Amount of Thickened Sludge Generated from Franchise Treatment Plants

	(Pa1+Lb1)	Pb1	Pc	(Pd+Le)	La1	(La2+Ld2)	Total
Net（m^3/day）	189	140	120	68	150	252	667
Gross（m^3/day）（net × 365/240）	287	213	183	103	228	383	1,014

- Necessary motor lorry number: Vcn=Fts/(10t×Rt)
  Table 8-2-20 shows the necessary number of motor lorries from each franchise treatment plant.

Table 8-2-20 Necessary motor lorry number

	(Pa1+Lb1)	Pb1	Pc	(Pd+Le)	La1	(La2+Ld2)	Total
Fts（m^3/day）	287	213	183	103	228	383	1,014
Rt(hour)	4	4	4	4	4	4	4
Vcn(set)	72	54	46	26	57	96	254

- Total transportation cost: Ttc (peso)=Fts×200peso
  Table 8-2-21 shows the results of calculating the total transportation cost.

Table 8-2-21 Total transportation cost of Thickened Sludge

	(Pa1+Lb1)	Pb1	Pc	(Pd+Le)	La1	(La2+Ld2)	Total
Fts m3/d	287	213	183	103	228	383	1014
unit price peso/m3	200	200	200	200	200	200	200
Ttc p/day	57,400	42,600	36,600	20,600	45,600	76,600	202,800
Ttc p/mo	1,134,000	840,000	720,000	408,000	900,000	1,512,000	4,002,000
Ttc p/yr	13,776,000	10,224,000	8,784,000	4,944,000	10,944,000	18,384,000	48,672,000

(b) Sludge cake transportation cost

Table 8-2-22 shows the results of calculating the sludge cake transportation cost assuming the unit cost is the same as for thickened sludge, i.e. 200 peso/m3.

Table 8-2-22 Total transportation cost of Sludge Cake

		(Pa1+Lb1)	(Pa2+Lb2)	Pb1	Pc	(Pd+Le)	La1	La2+Ld2	Total
Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering(In case of the on-site approach)									
Sludge Cake m3/d		16	31	12	10	6	12	4	91
unit price peso/m3		200	200	200	200	200	200	200	
Total transportation cost	peso/day	3,200	6,200	2,400	2,000	1,200	2,400	740	18,140
	peso/mo	96,000	186,000	72,000	60,000	36,000	72,000	22,200	544,200
	peso/yr	1,168,000	2,263,000	876,000	730,000	438,000	876,000	270,100	6,621,100
Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering(In case of the off-site approach)									
Sludge Cake m3/d			91						91
unit price peso/m3			200						
Total transportation cost	peso/day		18,140						18,140
	peso/mo		544,200						544,200
	peso/yr		6,621,100						6,621,100
Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering(In case of the on-site approach)									
Sludge Cake m3/d		21	42	16	14	8	17	29	147
unit price peso/m3		200	200	200	200	200	200	200	
Total transportation cost	peso/day	4,200	8,400	3,200	2,800	1,600	3,400	5,800	29,400
	peso/mo	126,000	252,000	96,000	84,000	48,000	102,000	174,000	882,000
	peso/yr	1,533,000	3,066,000	1,168,000	1,022,000	584,000	1,241,000	2,117,000	10,731,000
Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering(In case of the off-site approach)									
Sludge Cake m3/d			147						147
unit price peso/m3			200						
Total transportation cost	peso/day		29,400						29,400
	peso/mo		882,000						882,000
	peso/yr		10,731,000						10,731,000

d) Comparison of economy

Economic examination was conducted upon carrying out rough capacity calculation for each case. **Table 8-2-23** shows a comparison of equipment lists calculated using the aforementioned design load of each facility. Moreover, **Table 8-2-24** shows the results of calculating the rough equipment cost including the equipment list and sludge transportation cost. **Tables 8-2-25** through **8-2-38** show the basis for calculation of this rough equipment cost and operation cost.

Table 8-2-23 Comparison of Equipment Lists

Items	unit	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering														Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering													
		In case of the on-site approach							In case of the off-site approach							In case of the on-site approach							In case of the off-site approach						
		Pa1+Lb1	Pa2+Pb2	Pb1	Pc	Pd+Pe	La1	La2+Ld2	Pa1+Lb1	Pa2+Pb2	Pb1	Pc	Pd+Pe	La1	La2+Ld2	Pa1+Lb1	Pa2+Pb2	Pb1	Pc	Pd+Pe	La1	La2+Ld2	Pa1+Lb1	Pa2+Pb2	Pb1	Pc	Pd+Pe	La1	La2+Ld2
1.Design Condition																													
4)Generated Sludge Volume																													
Solids	t/d	5.71	11.27	4.23	3.63	2.05	4.52	7.61	5.56	11.86	4.12	3.53	2	4.4	7.41	5.85	11.57	4.34	3.72	2.1	4.64	7.8	5.56	10.99	4.12	3.53	2	4.4	8.31
Sludge Volume	m^3/d	952	1,878	705	605	342	753	1268	927	1,977	687	588	333	733	1,235	975	1928	723	620	350	773	1300	927	1832	687	588	333	733	1385
Sludge Concentration	%	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
2.Sludge Thickening Facilities																													
1)Sludge Thickening Process		Gravity thickening							Gravity thickening							Gravity thickening							Gravity thickening						
2)Gravity Thickeningu Tank																													
Type of Tank		Round shape							Round shape							Round shape							Round shape						
Diameter	m	8.00	8.00	7.00	6.50	5.00	7.00	7.50	8.00	8.00	7.00	6.50	5.00	7.00	8.00	8.00	8.00	7.00	6.50	5.00	7.50	7.50	8.00	8.00	7.00	6.50	5.00	7.00	8.00
Water Depth	m	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Number of Tanks	sets	2	4	2	2	2	2	3	2	4	2	2	2	2.00	3.00	2	4	2	2	2	2	3	2	4	2	2	2	2	3
3)Thickened Sludge Collector																													
Type of Collector		Central drive suspended Pattern							Central drive suspended Pattern							Central drive suspended Pattern							Central drive suspended Pattern						
Tank Size	m	8.00	8.00	7.00	6.50	5.00	7.00	7.50	8.00	8.00	7.00	6.50	5.00	7.00	8.00	8.00	8.00	7.00	6.50	5.00	7.50	7.50	8.00	8.00	7.00	6.50	5.00	7.00	8.00
Collection Speed	m/min	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3	2～3
Motor Output	kW	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.40	0.40	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.40	0.40	0.40	0.40	0.4	0.4
Number of Units	sete	2	4	2	2	2	2	3	2	4	2	2	2	2	3	2	4	2	2	2	2	3	2	4	2	2	2	2	3
4)Thickened Sludge Transfer Pump																													
Type of Pump		Unaxial screw pump							Horizontal nonclogging sludge pump							Horizontal nonclogging sludge pump							Horizontal nonclogging sludge pump						
Diameter	mm	φ100	φ100	φ80	φ100	φ100	φ100	φ100	φ100	φ100	φ100	φ100	φ80	φ100	φ100	φ100	φ100	φ100	φ100	φ80	φ100	φ100	φ100	φ100	φ100	φ100	φ80	φ100	φ100
Capacity	m^3/min	0.10	0.15	0.10	0.10	0.10	0.15	0.10	0.50	0.50	0.30	0.30	0.20	0.5	0.3	0.50	0.50	0.50	0.50	0.20	0.5	0.5	0.5	0.5	0.3	0.3	0.2	0.5	0.3
Total Pump Head	m	15.0	15.0	15.0	15.0	15.0	15.0	15.0	10.0	10.0	10.0	10.0	10.0	10	10	10.00	10.00	10.00	10.00	10.00	10	10	10.00	10.00	10.00	10.00	10.00	10	10
Motor Output	kW	3.7	3.7	2.2	2.2	2.2	3.7	2.2	3.7	3.7	2.2	2.2	1.5	3.7	2.2	3.7	3.7	3.7	3.7	1.5	3.7	3.7	3.7	3.7	2.2	2.2	1.5	3.7	2.2
Number of punps	unit	3(1)	4(1)	2(1)	2(1)	2(1)	2(1)	3(1)	2(1)	3(1)	2(1)	2(1)	2(1)	2(1)	3(1)	2(1)	3(1)	2(1)	2(1)	3(1)	2(1)	3(1)	2(1)	3(1)	2(1)	2(1)	2(1)	2(1)	3(1)
5)Thickened Sludge Volume																													
Solids	t/d	4.85	9.58	3.6	3.09	1.74	3.84	6.47	4.73	10.08	3.5	3	1.7	3.74	6.3	4.97	9.83	3.69	3.16	1.79	3.94	6.63	4.73	9.34	3.5	3	1.7	3.74	7.06
									33.05														33.07						
Sludge Volume	m^3/d	194	383	144	124	70	154	259	189	403	140	120	68	150	252	199	393	148	126	72	158	265	189	374	140	120	68	150	282
									1,322														1,323						
Sludge Concentration	%	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
3.Thickened Sludge Storage Tank																													
1)Type of Storage Tank									Mechanical mixing type														Mechanical mixing type						
2)Storage Tank																													
Width	m								8.50	10.00	7.50	7.00	5.50	7.50	8.50								8.50	10.00	7.50	6.50	5.50	7.50	8.50
Length	m								8.50	10.00	7.00	6.50	5.00	7.50	8.50								8.50	10.00	7.50	7.00	5.00	7.50	8.50
Water Depth	m								4.00	5.00	4.00	4.00	4.00	4.00	4.00								4.00	5.00	4.00	4.00	4.00	4.00	4.00
Number of Tanks	sets								2	8	2	2	2	2	3								2	8	2	2	2	2	3
3)storage Tank Mixer																													
Type of Mixer									Vertical double paddle														Vertical double paddle						
Mixing Capacity	m^3								320	550	230	200	120	240	320								320	550	250	200	120	250	320
Blade Diameter	m								2.50	2.50	2.00	2.00	1.50	2.00	2.50								2.50	2.50	2.00	2.00	1.50	2.00	2.50
Motor Output	kW								37.0	55.0	30.0	22.0	15.0	30.0	37.0								37.0	55.0	30.0	22.0	15.0	30.0	37.0
Number of Units	units								2	8	2	2	2	2	3								2	8	2	2	2	2	3
4)Sludge Feed Pump																													
Type of Pump									Unaxial screw pump														Horizontal nonclogging sludge pump						
Diameter	mm									φ150														φ100					
Capacity	m^3/min									0.50														0.5					
Total Pump Head	m									15.0														10					
Motor Output	kW									11.0														3.7					
Number of punps	units									3(1)														3(1)					
4.Sludge Digestion																													
1)Digestion System		Anaerobic digestion single-stage system							Anaerobic digestion single-stage system																				
2)Type of sludge digestion tank in case of Cylindrical																													
2)-1 Digestion Tank																													
Diameter	m	19.00	18.00	17.00	16.00	14.00	17.00	18.00		24.00																			
Water Depth	m	9.00	10.00	8.00	8.00	7.00	8.50	9.00		12.50																			
Number of Tanks	sets	2	4	2	2	2	2	3		6																			
2)-2 Digestion Tank Mixer																													
Type of Mixer		Self-support mechanical mixer							Self-support mechanical mixer																				
Guide Pipe Diameter	m	400	400	400	400	400	400	400		800																			
Recircuration Quantity	m^3/min	21.3	21.1	16.1	13.4	9	16.1	19.1		47.1																			
Motor Output	kw	7.5	7.5	5.5	5.5	3.7	5.5	7.5		15																			
Number of Units	unit	2	4	2	2	2	2	3		6																			
3)Generated Sludge-Digestion Gas																													
Gas Quantity	m^3/d	2,328	4,598	1,728	1,483	835	1,843	3,106		15,864																			
4)Gas Holder																													
Type of Gas Holder		Dry type							Dry type																				
Capacity	m^3	600	1500	500	400	300	500	600		3000																			
Number of Holder	sets	2	2	2	2	2	2	3		3																			
5)Desulfurizer																													
Type of Desulfurizer		Dry desulfurizer							Dry desulfurizer																				
Capacity	m^3/hr	50	100	50	50	25	50	50		150																			
Number of Units	units	2	2	2	2	2	2	3		6																			
6)Excess Gas Combustion Equipment																													
Type		Furnace combustion type							Furnace combustion type																				
Capasity	m^3/hr	50	100	50	50	50	50	50		150																			
Motor Output	kW	5.48																											
Numbe of Units	units	2	2	2	2	1	2	3		6																			
8)Digested Sludge Volume																													
Solids	t/d	2.91	5.75	2.16	1.85	1.04	2.3	3.88		19.83																			
Sludge Volume	m^3/d	194	383	144	124	70	154	259		1322																			
Sludge Concentration	%	1.5	1.5	1.5	1.5	1.5	1.5	1.5		1.5																			
5.Sludge Storage Tank																													
1)Type of Storage Tank		Mechanical mixing type							Mechanical mixing type							Mechanical mixing type							Mechanical mixing type						
2)Storage Tank																													
Width	m	6.00	7.00	5.50	5.00	5.50	5.50	6.00		10.00						6.50	7.00	5.50	5.00	5.50	5.50	6.00		8.00					
Length	m	6.00	7.00	5.00	5.00	5.00	5.50	5.50		10.00						6.00	7.00	5.00	5.00	5.00	5.50	5.50		8.00					
Water Depth	m	4.00	4.00	4.00	4.00	4.00	4.00	4.00		5.00						4.00	4.00	4.00	4.00	4.00	4.00	4.00		4.00					
Number of Tanks	sets	4	6	4	4	2	4	6		8						4	6	4	4	2	4	6		8					
3)storage Tank Mixer																													
Type of Mixer		Vertical double paddle							Vertical double paddle							Vertical double paddle							Vertical double paddle						
Mixing Capacity	m^3	160	220	130	110	110	140	150		550						180	220	130	110	120	140	150		300					
Blade Diameter	m	1.70	2.00	1.70	1.50	1.70	1.70	1.70		2.50						2.00	2.00	1.70	1.50	1.70	1.70	1.70		2.50					
Motor Output	kW	18.5	22.0	15.0	11.0	11.0	15.0	15.0		55.0						18.5	22.0	15.0	11.0	15.0	15	15		30.0					
Number of Units	units	4	6	4	4	2	4	6		8						4	6	4	4	2	4	6		8					
4)Sludge Feed Pump																													
Type of Pump		Unaxial screw pump							Unaxial screw pump							Unaxial screw pump							Unaxial screw pump						
Diameter	mm	φ100	φ100	φ100	φ100	φ80	φ100	φ100		φ150						φ100	φ100	φ100	φ100	φ100	φ100	φ100		φ150					
Capacity	m^3/min	0.20	0.20	0.20	0.20	0.05	0.20	0.20		0.50						0.20	0.20	0.20	0.20	0.05	0.2	0.2		0.5					
Total Pump Head	m	20.0	20.0	20.0	20.0	20.0	20.0	20.0		20.0						20.0	20.0	20.0	20.0	20.0	20	20		20					
Motor Output	kW	5.5	5.5	5.5	5.5	1.5	5.5	5.5		15.0						5.5	5.5	5.5	5.5	1.5	5.5	5.5		15					
Number of punps	units	3(1)	5(1)	3(1)	3(1)	3(1)	3(1)	4(1)		7(1)						3(1)	5(1)	3(1)	3(1)	3(1)	3(1)	4(1)		7(1)					
6.Sludge Dewatering Equipment																													
1)In case of Pressuer Insention Screw Press Dewatering Machine type																													
Screen Diameter	mm	800	800	700	600	500	700	700		1100						800	800	700	600	500	700	700		1100					
Motor Output	kW	4.1	4.1	4.1	4.1	2.25	4.1	4.1		10						4.1	4.1	4.1	4.1	2.25	4.1	4.1		10					
Number of Units	units	2	4	2	2	2	2	3		6						2	4	2	2	2	2	3		6					
2)Chemical-dosage	kg/d	62	122	46	39	22	49	83		422						91	179	67	58	33	72	121		604					
3)Chemical solution tank																													
Type of tank		Steel cylinder tank							Steel cylinder tank							Steel cylinder tank							Steel cylinder tank						
Capacity	m3	3	6	2	2	2	2	3		6						5	9	4	4	3	4	5		9					
Mixing power	kW	2.2	3.7	1.5	1.5	1.5	1.5	2.2		3.7						3.7	5.5	2.2	2.2	1.5	2.2	2.2		5.5					
Number of tank	units	2	2	2	2	2	2	3		6						2	2	2	2	2	2	3		6					
4)Chemical feed pump																													
Type of Pump		Unaxial screw pump							Unaxial screw pump							Unaxial screw pump							Unaxial screw pump						
Bore diameter	mm	50	50	50	50	50	50	50		50						50	50	50	50	50	50	50		50					
Discharge rate	m^3/min	0.01～0.03	0.01～0.03	0.01～0.02	0.01～0.02	0.00～0.01	0.00～0.02	0.01～0.03		0.02～0.07						20.00～0.00	20.00～0.00	20.00～0.00	20.00～0.00	20.00～0.00	20.00～0.00	20.00～0.00		0.04～0.11					
Total head	m	20	20	20	20	20	20	20		20						1.5	1.5	1.5	1.5	1.5	1.5	1.5		20					
Motor Output	kW	1.5	1.5	1.5	1.5	1.5	1.5	1.5		2.2						1.5	1.5	1.5	1.5	1.5	1.5	1.5		3.7					
Number of punps	units	3(1)	5(1)	3(1)	3(1)	3(1)	3(1)	4(1)		7(1)						3(1)	5(1)	3(1)	3(1)	3(1)	3(1)	4(1)		7(1)					
5)Chemical feeder																													
Type		Positive displacement piece feeder							Positive displacement piece feeder							Positive displacement piece feeder							Positive displacement piece feeder						
Feed rate	L/min	0.5～1	1～2	0.3～1	0.3～1	0.3～1	0.3～1	0.5～1		1～2						0.5～2	1～3	0.5～2	0.5～2	0.3～1	0.5～2	0.5～2		1.5～3					
Storage discharge	L	100	100	100	100	100	100	100		100						100	100	100	100	100	100	100		100					
Motor Output	kW	0.4	0.4	0.4	0.4	0.4	0.4	0.4		0.4						0.4	0.4	0.4	0.4	0.4	0.4	0.4		0.4					
Number of feeder	units	2	2	2	2	2	2	3		6						2	2	2	2	2	2	3		6					
7.Sludge Cake Quantity																													
Solids	t/d	2.8	5.5	2.1	1.8	1	2.2	3.7		18.8						4.7	9.3	3.5	3	1.7	3.7	6.3		31.4					
Cake Volume	m^3/d	16	31	12	10	6	12	21		104						21	42	16	14	8	17	29		143					
Cake Water Concentration	%	82	82	82	82	82	82	82		82						78	78	78	78	78	78	78		78					
8.Cake storage hopper																													
Type of hopper		Electric cut gate							Electric cut gate							Electric cut gate							Electric cut gate						
Capacity	m3	8	12	6	5	3	6	12		12						12	12	8	7	4	10	10		12					
Motor Output	kw	3	3	3	3	3	3	3		3						3	3	3	3	3	3	3		3					
Number of hopper	units	2	3	2	2	2	2	2		9						2	4	2	2	2	2	3		13					

Table 8-2-24 Economic Comparison of Sludge Treatment Methods

Items	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering								Remarks
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach				
	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	
＜Cost of Equipment＞																	
1.Pa1+Lb1 S.T.P				624,587,250				51,202,200				221,846,100				51,202,200	
2.Pa2+Pb2 S.T.P				974,760,150				2,363,211,900				353,137,050				766,223,850	
3.Pb1 S.T.P				550,440,450				45,807,300				190,807,050				45,807,300	
4.Pc S.T.P				520,941,750				45,651,900				171,094,350				45,651,900	
5.Pd+Pe S.T.P				441,696,150				37,012,500				142,395,750				37,012,500	
6.La1 S.T.P				550,486,650				45,853,500				192,340,050				45,853,500	
7.La2+Ld2 S.T.P				901,503,750				56,800,800				613,251,450				75,411,000	
subtotal				4,564,416,150				2,645,540,100				1,884,871,800				1,067,162,250	
＜Staff Costs＞																	
1.Pa1+Lb1 S.T.P	960,000	10		9,600,000				0	960,000	10		9,600,000				0	
2.Pa2+Pb2 S.T.P	960,000	10		9,600,000	960,000	10		9,600,000	960,000	10		9,600,000	960,000	10		9,600,000	
3.Pb1 S.T.P	960,000	10		9,600,000				0	960,000	10		9,600,000				0	
4.Pc S.T.P	960,000	10		9,600,000				0	960,000	10		9,600,000				0	
5.Pd+Pe S.T.P	960,000	10		9,600,000				0	960,000	10		9,600,000				0	
6.La1 S.T.P	960,000	10		9,600,000				0	960,000	10		9,600,000				0	
7.La2+Ld2 S.T.P	960,000	10		9,600,000				0	960,000	10		9,600,000				0	
subtotal				67,200,000				9,600,000				67,200,000				9,600,000	
＜Electricity Rate＞																	
1.Pa1+Lb1 S.T.P	3,732,150	10		37,321,500	4,813,620	10		48,136,200	2,649,980	10		26,499,800	4,813,620	10		48,136,200	
2.Pa2+Pb2 S.T.P	6,781,530	10		67,815,300	48,481,340	10		484,813,400	4,856,980	10		48,569,800	27,961,920	10		279,619,200	
3.Pb1 S.T.P	2,928,830	10		29,288,300	3,955,140	10		39,551,400	2,284,410	10		22,844,100	3,955,140	10		39,551,400	
4.Pc S.T.P	2,584,760	10		25,847,600	2,974,020	10		29,740,200	1,940,350	10		19,403,500	2,974,020	10		29,740,200	
5.Pd+Pe S.T.P	1,639,330	10		16,393,300	2,115,540	10		21,155,400	1,357,590	10		13,575,900	2,115,540	10		21,155,400	
6.La1 S.T.P	2,928,830	10		29,288,300	3,955,140	10		39,551,400	2,284,410	10		22,844,100	3,955,140	10		39,551,400	
7.La2+Ld2 S.T.P	4,487,330	10		44,873,300	7,149,910	10		71,499,100	3,540,060	10		35,400,600	1,166	10		11,660	
subtotal				250,827,600				734,447,100				189,137,800				457,765,460	
＜Chemical-dosage cost＞																	
1.Pa1+Lb1 S.T.P	11,315,000	10		113,150,000	0	10		0	16,607,500	10		166,075,000	0	10		0	
2.Pa2+Pb2 S.T.P	22,265,000	10		222,650,000	77,015,000	10		770,150,000	32,667,500	10		326,675,000	110,230,000	10		1,102,300,000	
3.Pb1 S.T.P	8,395,000	10		83,950,000	0	10		0	12,227,500	10		122,275,000	0	10		0	
4.Pc S.T.P	7,117,500	10		71,175,000	0	10		0	10,585,000	10		105,850,000	0	10		0	
5.Pd+Pe S.T.P	4,015,000	10		40,150,000	0	10		0	6,022,500	10		60,225,000	0	10		0	
6.La1 S.T.P	8,942,500	10		89,425,000	0	10		0	13,140,000	10		131,400,000	0	10		0	
7.La2+Ld2 S.T.P	15,147,500	10		151,475,000	0	10		0	22,082,500	10		220,825,000	0	10		0	
subtotal				771,975,000				770,150,000				1,133,325,000				1,102,300,000	
＜Thickened Sludge Transport Cost＞																	
subtotal					48,672,000	10		486,720,000					48,672,000	10		486,720,000	
＜Sludge Cake Transport Cost＞																	
subtotal	6,621,100	10		66,211,000	6,621,100	10		66,211,000	10,731,000	10		107,310,000	10,731,000	10		107,310,000	
＜Rework Cost＞																	
1.Pa1+Lb1 S.T.P	5,948,450	10		59,484,500	487,640	10		4,876,400	2,112,820	10		21,128,200	487,640	10		4,876,400	
2.Pa2+Pb2 S.T.P	9,283,430	10		92,834,300	22,506,780	10		225,067,800	3,363,210	10		33,632,100	7,297,370	10		72,973,700	
3.Pb1 S.T.P	5,242,290	10		52,422,900	436,260	10		4,362,600	1,817,210	10		18,172,100	436,260	10		4,362,600	
4.Pc S.T.P	4,961,350	10		49,613,500	434,780	10		4,347,800	1,629,470	10		16,294,700	434,780	10		4,347,800	
5.Pd+Pe S.T.P	4,206,630	10		42,066,300	352,500	10		3,525,000	1,356,150	10		13,561,500	352,500	10		3,525,000	
6.La1 S.T.P	5,242,730	10		52,427,300	436,700	10		4,367,000	1,831,810	10		18,318,100	436,700	10		4,367,000	
7.La2+Ld2 S.T.P	8585750	10		85,857,500	540960	10		5,409,600	5840490	10		58,404,900	718200	10		7,182,000	
subtotal				434,706,300				251,956,200				179,511,600				101,634,500	
Eestimated Amount（peso)				6,155,336,050				4,964,624,400				3,561,356,200				3,332,492,210	

Table 8-2-25 Basis for Calculation of Rough Equipment Cost 1 (Pa1+Lb1 STP)

Item	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
1.Pa1+Lb1 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
1.Equipment cost																
1.1 Sludge Thickening Facilities																
1)Thickened Sludge Collector	Central drive suspended Pattern φ8.0m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw			
	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000
2)Thickened Sludge Transfer Pump	Unaxial screw pump φ100mm×15.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw			
	884,500	3		2,653,500	1,199,000	2		2,398,000	1,199,000	2		2,398,000	1,199,000	2		2,398,000
1.2 Thickened Sludge Storage Tank																
1)storage Tank Mixer	-				Vertical double paddle φ2.5m×37.0kw				-				Vertical double paddle φ2.5m×37.0kw			
					2,954,000	2		5,908,000					2,954,000	2		5,908,000
2)Sludge Feed Pump	-				-				-				-			
1.3 Sludge Digestion																
1) Digestion Tank Mixer	Self-support mechanical mixer 1278m3/H×7.5kw															
	28,841,500	2		57,683,000		-				-				-		
2)Gas Holder	Dry type 600m3															
	53,860,000	2		107,720,000		-				-				-		
3)Desulfurizer	Dry desulfurizer 50m3/H															
	8,222,500	2		16,445,000		-				-				-		
4)Excess Gas Combustion	Furnace combustion type 50m3/Hr															
Equipment	7,350,000	2		14,700,000		-				-				-		
1.4 Sludge Storage Tank																
1)storage Tank Mixer	Vertical double paddle φ1.70m×18.5kw								Vertical double paddle φ2.00m×18.5kw							
	1,625,000	4		6,500,000		-			1,625,000	4		6,500,000				
2)Sludge Feed Pump	Unaxial screw pump φ100mm×20.0m×5.5kw								Unaxial screw pump φ100mm×20.0m×5.5kw							
	2,210,500	3		6,631,500					2,210,500	3		6,631,500				
1.5 Sludge Dewatering Equipment																
Dewatering Equipment	Pressuer Insention Screw Press φ800mm×4.1kw								Pressuer Insention Screw Press φ800mm×4.1kw							
	18,950,000	2		37,900,000					18,950,000	2		37,900,000				
Chemical solution tank	Steel cylinder tank 3m3×2.2kw								Steel cylinder tank 5m3×3.7kw							
	1,879,000	2		3,758,000					3,615,000	2		7,230,000				
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw								Unaxial screw pump φ50mm×1.5kw							
	1,542,500	3		4,627,500					1,542,500	3		4,627,500				
Chemical feeder	Positive displacement piece feeder 1.0L/min×100L×0.4kw								Positive displacement piece feeder 1.0L/min×100L×0.4kw							
	2,399,000	2		4,798,000					2,399,000	2		4,798,000				
Cake storage hopper	Electric cut gate 8m3×3kw								Electric cut gate 12m3×3kw							
	8,965,000	2		17,930,000					9,740,000	2		19,480,000				
Total				297,422,500				24,382,000				105,641,000				24,382,000
2.Piping-installation cost	It assumes 50 % of the equipment cost.															
	297,422,500	0.5		148,711,250	24,382,000	0.5		12,191,000	105,641,000	0.5		52,820,500	24,382,000	0.5		12,191,000
3.Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.															
	446,133,750	0.4		178,453,500	36,573,000	0.4		14,629,200	158,461,500	0.4		63,384,600	36,573,000	0.4		14,629,200
Cost of Equipment				624,587,250				51,202,200				221,846,100				51,202,200

Table 8-2-26 Basis for Calculation of Rough Operation Cost 1 (Pa1+Lb1 STP)

Item	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
1.Pa1+Lb1 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	0	persons	0	240,000	4	persons	960,000	240,000	0	persons	0
②Electricity Rate																
Electric capacity																
Thickened Sludge Collector	0.4	2	0.8		0.4	2	0.8		0.4	2	0.8		0.4	2	0.8	
Thickened Sludge Transfer Pump	3.7	2	7.4		3.7	1	3.7		3.7	1	3.7		3.7	1	3.7	
storage Tank Mixer		-			37	2	74			-			37	2	74	
Sludge Feed Pump		-				-				-				-		
Digestion Tank Mixer	7.5	2	15			-				-				-		
subtotal			23.2				78.5				4.5				78.5	
	23.2kw×0.7×24hr×365day				78.5kw×0.7×24hr×365day				4.5kw×0.7×24hr×365day				78.5kw×0.7×24hr×365day			
			142,262				481,362				27,594				481,362	
storage Tank Mixer	18.5	4	74						18.5	4	74					
Sludge Feed Pump	5.5	2	11						5.5	2	11					
Dewatering Equipment	4.1	2	8.2						4.1	2	8.2					
Chemical solution tank	2.2	2	4.4						3.7	2	7.4					
Chemical feed pump	1.5	2	3						1.5	2	3					
Chemical feeder	0.4	2	0.8						0.4	2	0.8					
Cake storage hopper	3	2	6						3	2	6					
			107.4								110.4					
	107.4kw×0.7×12.8hr×240day								110.4kw×0.7×12.8hr×240day							
			230,953								237,404					
Electricity Rate(peso/yrs)	10	373,215		3,732,150	10	481,362		4,813,620	10	264,998		2,649,980	10	481,362		4,813,620
③Chemical-dosage cost	62kg/d×365days=		22630						91kg/d×365days=		33215					
(peso/yr)	500	22630		11,315,000					500	33215		16,607,500				
④Rework Cost(peso/yr)	It assumes 2% of the equipment cost.															
	297,422,500	0.02		5,948,450	24,382,000	0.02		487,640	105,641,000	0.02		2,112,820	24,382,000	0.02		487,640

Table 8-2-27 Basis for Calculation of Rough Equipment Cost 2 (Pa2+Lb2 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
2.Pa2+Pb2 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
1.Equipment cost																
1.1 Sludge Thickening Facilities																
1)Thickened Sludge Collector	Central drive suspended Pattern φ8.0m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw			
	8,038,000	4		32,152,000	8,038,000	4		32,152,000	8,038,000	4		32,152,000	8,038,000	4		32,152,000
2)Thickened Sludge Transfer Pump	Unaxial screw pump φ100mm×15.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw			
	884,500	4		3,538,000	1,199,000	3		3,597,000	1,199,000	3		3,597,000	1,199,000	3		3,597,000
1.2 Thickened Sludge Storage Tank																
1)storage Tank Mixer	-				Vertical double paddle φ2.5m×55.0kw				-				Vertical double paddle φ2.5m×55.0kw			
					2,962,000	3		8,886,000					2,914,000	8		23,312,000
2)Sludge Feed Pump	-				Unaxial screw pump φ150mm×15.0m×11.0kw				-				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw			
					2,191,500	3		6,574,500					989,000	3		2,967,000
1.3 Sludge Digestion																
1) Digestion Tank Mixer	Self-support mechanical mixer 1266m3/H×7.5kw				Self-support mechanical mixer 2826m3/H×15.0kw											
	28,841,500	4		115,366,000	46,605,000	6		279,630,000		-				-		
2)Gas Holder	Dry type 1500m3				Dry type 3000m3											
	82,239,000	2		164,478,000	112,193,500	3		336,580,500		-				-		
3)Desulfurizer	Dry desulfurizer 100m3/H				Dry desulfurizer 150m3/H											
	6,672,000	2		13,344,000	10,412,000	6		62,472,000		-				-		
4)Excess Gas Combustion	Furnace combustion type 100m3/Hr				Furnace combustion type 150m3/Hr											
Equipment	7,350,000	2		14,700,000	9,750,000	6		58,500,000		-				-		
1.4 Sludge Storage Tank																
1)storage Tank Mixer	Vertical double paddle φ2.00m×22.0kw				Vertical double paddle φ2.50m×55.0kw				Vertical double paddle φ2.00m×22.0kw				Vertical double paddle φ2.50m×30.0kw			
	1,643,500	6		9,861,000	3,132,500	8		25,060,000	1,643,500	6		9,861,000	2,905,500	8		23,244,000
2)Sludge Feed Pump	Unaxial screw pump φ100mm×20.0m×5.5kw				Unaxial screw pump φ150mm×20.0m×15.0kw				Unaxial screw pump φ100mm×20.0m×5.5kw				Unaxial screw pump φ150mm×20.0m×15.0kw			
	895,000	5		4,475,000	2,263,500	7		15,844,500	895,000	5		4,475,000	2,300,000	7		16,100,000
1.5 Sludge Dewatering Equipment																
Dewatering Equipment	Pressuer Insention Screw Press φ800mm×4.1kw				Pressuer Insention Screw Press φ1100mm×10.0kw				Pressuer Insention Screw Press φ800mm×4.1kw				Pressuer Insention Screw Press φ1100mm×10.0kw			
	15,950,000	4		63,800,000	27,950,000	6		167,700,000	15,950,000	4		63,800,000	15,500,000	6		93,000,000
Chemical solution tank	Steel cylinder tank 6m3×3.7kw				Steel cylinder tank 6m3×3.7kw				Steel cylinder tank 9m3×5.5kw				Steel cylinder tank 9m3×5.5kw			
	2,576,000	2		5,152,000	2,576,000	6		15,456,000	3,615,000	2		7,230,000	3,615,000	6		21,690,000
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw				Unaxial screw pump φ50mm×2.2kw				Unaxial screw pump φ50mm×1.5kw				Unaxial screw pump φ50mm×3.7kw			
	657,500	5		3,287,500	1,547,500	7		10,832,500	657,500	5		3,287,500	1,558,500	5		7,792,500
Chemical feeder	Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 2.0L/min×100L×0.4kw				Positive displacement piece feeder 3.0L/min×100L×0.4kw				Positive displacement piece feeder 3.0L/min×100L×0.4kw			
	2,399,000	2		4,798,000	2,399,000	6		14,394,000	2,399,000	2		4,798,000	2,399,000	6		14,394,000
Cake storage hopper	Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw				Electric cut gate 12m3×3kw			
	9,740,000	3		29,220,000	9,740,000	9		87,660,000	9,740,000	4		38,960,000	9,740,000	13		126,620,000
Total				464,171,500				1,125,339,000				168,160,500				364,868,500
2.Piping-installation cost	It assumes 50 % of the equipment cost.															
	464,171,500	0.5		232,085,750	1,125,339,000	0.5		562,669,500	168,160,500	0.5		84,080,250	364,868,500	0.5		182,434,250
3.Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.															
	696,257,250	0.4		278,502,900	1,688,008,500	0.4		675,203,400	252,240,750	0.4		100,896,300	547,302,750	0.4		218,921,100
Cost of Equipment	Equipment cost+Piping-installation cost+Electric equipment cost															
				974,760,150				2,363,211,900				353,137,050				766,223,850

Table 8-2-28 Basis for Calculation of Rough Operation Cost 2 (Pa2+Lb2 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
2.Pa2+Pb2 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000
②Electricity Rate																
Electric capacity																
Thickened Sludge Collector	0.4	4	1.6		0.4	4	1.6		0.4	4	1.6		0.4	3	1.2	
Thickened Sludge Transfer Pump	3.7	3	11.1		3.7	2	7.4		3.7	2	7.4		3.7	2	7.4	
storage Tank Mixer		-			55	8	440			-			55	8	440	
Sludge Feed Pump		-			11	2	22			-			3.7	2	7.4	
Digestion Tank Mixer	7.5	4	30		15	6	90			-						
subtotal			42.7				561				9				456	
	42.7kw×0.7×24hr×365day				561kw×0.7×24hr×365day				9kw×0.7×24hr×365day				456kw×0.7×24hr×365day			
			261,836				3,440,052				55,188				2,796,192	
storage Tank Mixer	22	6	132		55	8	440		22	6	132					
Sludge Feed Pump	5.5	4	22		15	6	90		5.5	4	22					
Dewatering Equipment	4.1	4	16.4		10	6	60		4.1	4	16.4					
Chemical solution tank	3.7	2	7.4		3.7	6	22.2		5.5	2	11					
Chemical feed pump	1.5	4	6		2.2	6	13.2		1.5	4	6					
Chemical feeder	0.4	2	0.8		0.4	6	2.4		0.4	2	0.8					
Cake storage hopper	3	3	9		3	9	27		3	4	12					
			193.6				654.8				200.2					
	193.6kw×0.7×12.8hr×240day				654.8kw×0.7×12.8hr×240day				200.2kw×0.7×12.8hr×240day							
			416,317				1,408,082				430,510					
Electricity Rate(peso/yrs)	10	678,153		6,781,530	10	4,848,134		48,481,340	10	485,698		4,856,980	10	2,796,192		27,961,920
③Chemical-dosage cost	122kg/d×365days=		44530		422kg/d×365days=		154030		179kg/d×365days=		65335		604kg/d×365days=		220460	
(peso/yr)	500	44530		22,265,000	500	154030		77,015,000	500	65335		32,667,500	500	220460		110,230,000
④Rework Cost(peso/yr)	It assumes 2% of the equipment cost.															
	464,171,500	0.02		9,283,430	1,125,339,000	0.02		22,506,780	168,160,500	0.02		3,363,210	364,868,500	0.02		7,297,370

Table 8-2-29 Basis for Calculation of Rough Equipment Cost 3 (Pb1 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
3.Pb1 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
1.Equipment cost																
1.1 Sludge Thickening Facilities																
1)Thickened Sludge Collector	Central drive suspended Pattern φ7.0m×0.4kw				Central drive suspended Pattern φ7.0m×0.4kw				Central drive suspended Pattern φ7.0m×0.4kw				Central drive suspended Pattern φ7.0m×0.4kw			
	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000
2)Thickened Sludge Transfer Pump	Unaxial screw pump φ80mm×15.0m×2.2kw				Horizontal nonclogging sludge pump φ100mm×10.0m×2.2kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×2.2kw			
	873,500	2		1,747,000	1,188,000	2		2,376,000	1,199,000	2		2,398,000	1,188,000	2		2,376,000
1.2 Thickened Sludge Storage Tank																
1)storage Tank Mixer	-				Vertical double paddle φ2.0m×30.0kw				-				Vertical double paddle φ2.0m×30.0kw			
					1,680,500	2		3,361,000					1,680,500	2		3,361,000
2)Sludge Feed Pump	-				-				-				-			
1.3 Sludge Digestion																
1) Digestion Tank Mixer	Self-support mechanical mixer 966m3/H×5.5kw															
	26,696,000	2		53,392,000		-				-				-		
2)Gas Holder	Dry type 500m3															
	48,115,500	2		96,231,000		-				-				-		
3)Desulfurizer	Dry desulfurizer 50m3/H															
	5,221,000	2		10,442,000		-				-				-		
4)Excess Gas Combustion	Furnace combustion type 50m3/Hr															
Equipment	7,350,000	2		14,700,000		-				-				-		
1.4 Sludge Storage Tank																
1)storage Tank Mixer	Vertical double paddle φ1.70m×15.0kw								Vertical double paddle φ1.70m×15.0kw							
	1,560,000	4		6,240,000		-			1,560,000	4		6,240,000				
2)Sludge Feed Pump	Unaxial screw pump φ100mm×20.0m×5.5kw								Unaxial screw pump φ100mm×20.0m×5.5kw							
	895,000	3		2,685,000					895,000	3		2,685,000				
1.5 Sludge Dewatering Equipment																
Dewatering Equipment	Pressuer Insention Screw Press φ700mm×4.1kw								Pressuer Insention Screw Press φ700mm×4.1kw							
	15,950,000	2		31,900,000					15,950,000	2		31,900,000				
Chemical solution tank	Steel cylinder tank 2m3×1.5kw								Steel cylinder tank 4m3×2.2kw							
	1,478,000	2		2,956,000					2,103,000	2		4,206,000				
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw								Unaxial screw pump φ50mm×1.5kw							
	1,542,500	3		4,627,500					1,542,500	3		4,627,500				
Chemical feeder	Positive displacement piece feeder 1.0L/min×100L×0.4kw								Positive displacement piece feeder 2.0L/min×100L×0.4kw							
	2,399,000	2		4,798,000					2,399,000	2		4,798,000				
Cake storage hopper	Electric cut gate 6m3×3kw								Electric cut gate 8m3×3kw							
	8,160,000	2		16,320,000					8,965,000	2		17,930,000				
Total				262,114,500				21,813,000				90,860,500				21,813,000
2.Piping-installation cost	It assumes 50 % of the equipment cost.															
	262,114,500	0.5		131,057,250	21,813,000	0.5		10,906,500	90,860,500	0.5		45,430,250	21,813,000	0.5		10,906,500
3.Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.															
	393,171,750	0.4		157,268,700	32,719,500	0.4		13,087,800	136,290,750	0.4		54,516,300	32,719,500	0.4		13,087,800
Cost of Equipment	Equipment cost+Piping-installation cost+Electric equipment cost															
				550,440,450				45,807,300				190,807,050				45,807,300

Table 8-2-30 Basis for Calculation of Rough Operation Cost 3 (Pb1 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
3.Pb1 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000
②Electricity Rate																
Electric capacity																
Thickened Sludge Collector	0.4	2	0.8		0.4	2	0.8		0.4	2	0.8		0.4	2	0.8	
Thickened Sludge Transfer Pump	3.7	1	3.7		3.7	1	3.7		3.7	1	3.7		3.7	1	3.7	
storage Tank Mixer		-			30	2	60			-			30	2	60	
Sludge Feed Pump		-				-				-				-		
Digestion Tank Mixer	5.5	2	11			-				-				-		
subtotal			15.5				64.5				4.5				64.5	
	15.5kw×0.7×24hr×365day				64.5kw×0.7×24hr×365day				4.5kw×0.7×24hr×365day				64.5kw×0.7×24hr×365day			
			95,046				395,514				27,594				395,514	
storage Tank Mixer	15	4	60						15	4	60					
Sludge Feed Pump	5.5	2	11						5.5	2	11					
Dewatering Equipment	4.1	2	8.2						4.1	2	8.2					
Chemical solution tank	1.5	2	3						2.2	2	4.4					
Chemical feed pump	1.5	2	3						1.5	2	3					
Chemical feeder	0.4	2	0.8						0.4	2	0.8					
Cake storage hopper	3	2	6						3	2	6					
subtotal			92								93.4					
	92kw×0.7×12.8hr×240day								93.4kw×0.7×12.8hr×240day							
			197,837								200,847					
Electricity Rate(peso/yrs)	10	292,883		2,928,830	10	395,514		3,955,140	10	228,441		2,284,410	10	395,514		3,955,140
③Chemical-dosage cost	46kg/d×365days=		16790						67kg/d×365days=		24455					
(peso/yr)	500	16790		8,395,000					500	24455		12,227,500				
④Rework Cost(peso/yr)	It assumes 2% of the equipment cost.															
	262,114,500	0.02		5,242,290	21,813,000	0.02		436,260	90,860,500	0.02		1,817,210	21,813,000	0.02		436,260

Table 8-2-31 Basis for Calculation of Rough Equipment Cost 4 (Pc STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
4.Pc S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
1.Equipment cost																
1.1 Sludge Thickening Facilities																
1)Thickened Sludge Collector	Central drive suspended Pattern φ6.5m×0.4kw				Central drive suspended Pattern φ6.5m×0.4kw				Central drive suspended Pattern φ6.5m×0.4kw				Central drive suspended Pattern φ6.5m×0.4kw			
	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000
2)Thickened Sludge Transfer Pump	Unaxial screw pump φ100mm×15.0m×2.2kw				Horizontal nonclogging sludge pump φ100mm×10.0m×2.2kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×2.2kw			
	873,500	2		1,747,000	1,188,000	2		2,376,000	1,199,000	2		2,398,000	1,188,000	2		2,376,000
1.2 Thickened Sludge Storage Tank																
1)storage Tank Mixer	-				Vertical double paddle φ2.0m×22.0kw				-				Vertical double paddle φ2.0m×22.0kw			
					1,643,500	2		3,287,000					1,643,500	2		3,287,000
2)Sludge Feed Pump	-				-				-				-			
1.3 Sludge Digestion																
1) Digestion Tank Mixer	Self-support mechanical mixer 804m3/H×5.5kw															
	28,792,000	2		57,584,000		-				-				-		
2)Gas Holder	Dry type 400m3															
	44,234,500	2		88,469,000		-				-				-		
3)Desulfurizer	Dry desulfurizer 50m3/H															
	5,176,000	2		10,352,000		-				-				-		
4)Excess Gas Combustion	Furnace combustion type 50m3/Hr															
Equipment	7,350,000	2		14,700,000		-				-				-		
1.4 Sludge Storage Tank																
1)storage Tank Mixer	Vertical double paddle φ1.50m×11.0kw								Vertical double paddle φ1.50m×11.0kw							
	1,132,000	4		4,528,000		-			1,132,000	4		4,528,000				
2)Sludge Feed Pump	Unaxial screw pump φ100mm×20.0m×5.5kw								Unaxial screw pump φ100mm×20.0m×5.5kw							
	895,000	3		2,685,000					895,000	3		2,685,000				
1.5 Sludge Dewatering Equipment																
Dewatering Equipment	Pressuer Insention Screw Press φ600mm×4.1kw								Pressuer Insention Screw Press φ600mm×4.1kw							
	13,650,000	2		27,300,000					13,650,000	2		27,300,000				
Chemical solution tank	Steel cylinder tank 2m3×1.5kw								Steel cylinder tank 4m3×2.2kw							
	1,478,000	2		2,956,000					2,103,000	2		4,206,000				
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw								Unaxial screw pump φ50mm×1.5kw							
	657,500	3		1,972,500					657,500	3		1,972,500				
Chemical feeder	Positive displacement piece feeder 1.0L/min×100L×0.4kw								Positive displacement piece feeder 2.0L/min×100L×0.4kw							
	2,399,000	2		4,798,000					2,399,000	2		4,798,000				
Cake storage hopper	Electric cut gate 5m3×3kw								Electric cut gate 7m3×3kw							
	7,450,000	2		14,900,000					8,755,000	2		17,510,000				
Total				248,067,500				21,739,000				81,473,500				21,739,000
2.Piping-installation cost	It assumes 50 % of the equipment cost.															
	248,067,500	0.5		124,033,750	21,739,000	0.5		10,869,500	81,473,500	0.5		40,736,750	21,739,000	0.5		10,869,500
3.Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.															
	372,101,250	0.4		148,840,500	32,608,500	0.4		13,043,400	122,210,250	0.4		48,884,100	32,608,500	0.4		13,043,400
Cost of Equipment																
				520,941,750				45,651,900				171,094,350				45,651,900

Table 8-2-32 Basis for Calculation of Rough Operation Cost 4 (Pc STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
4.Pc S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000
②Electricity Rate																
Electric capacity																
Thickened Sludge Collector	0.4	2	0.8		0.4	2	0.8		0.4	2	0.8		0.4	2	0.8	
Thickened Sludge Transfer Pump	3.7	1	3.7		3.7	1	3.7		3.7	1	3.7		3.7	1	3.7	
storage Tank Mixer		-			22	2	44			-			22	2	44	
Sludge Feed Pump		-				-				-				-		
Digestion Tank Mixer	5.5	2	11			-				-				-		
subtotal			15.5				48.5				4.5				48.5	
	15.5kw×0.7×24hr×365day				48.5kw×0.7×24hr×365day				4.5kw×0.7×24hr×365day				48.5kw×0.7×24hr×365day			
			95,046				297,402				27,594				297,402	
storage Tank Mixer	11	4	44						11	4	44					
Sludge Feed Pump	5.5	2	11						5.5	2	11					
Dewatering Equipment	4.1	2	8.2						4.1	2	8.2					
Chemical solution tank	1.5	2	3						2.2	2	4.4					
Chemical feed pump	1.5	2	3						1.5	2	3					
Chemical feeder	0.4	2	0.8						0.4	2	0.8					
Cake storage hopper	3	2	6						3	2	6					
subtotal			76								77.4					
	76kw×0.7×12.8hr×240day								77.4kw×0.7×12.8hr×240day							
			163,430								166,441					
Electricity Rate(peso/yrs)	10	258,476		2,584,760	10	297,402		2,974,020	10	194,035		1,940,350	10	297,402		2,974,020
③Chemical-dosage cost	39kg/d×365days=		14235						58kg/d×365days=		21170					
(peso/yr)	500	14235		7,117,500					500	21170		10,585,000				
④Rework Cost(peso/yr)	It assumes 2% of the equipment cost.															
	248,067,500	0.02		4,961,350	21,739,000	0.02		434,780	81,473,500	0.02		1,629,470	21,739,000	0.02		434,780
																3,934,020

Table 8-2-33 Basis for Calculation of Rough Equipment Cost 5 (Pd+Pe STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
5.Pd+Pe S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
1.Equipment cost																
1.1 Sludge Thickening Facilities																
1)Thickened Sludge Collector	Central drive suspended Pattern φ5.0m×0.4kw				Central drive suspended Pattern φ5.0m×0.4kw				Central drive suspended Pattern φ5.0m×0.4kw				Central drive suspended Pattern φ5.0m×0.4kw			
	6,692,500	2		13,385,000	6,692,500	2		13,385,000	6,692,500	2		13,385,000	6,692,500	2		13,385,000
2)Thickened Sludge Transfer Pump	Unaxial screw pump φ100mm×15.0m×2.2kw				Horizontal nonclogging sludge pump φ80mm×10.0m×1.5kw				Horizontal nonclogging sludge pump φ80mm×10.0m×1.5kw				Horizontal nonclogging sludge pump φ80mm×10.0m×1.5kw			
	1,000,000	2		2,000,000	973,000	2		1,946,000	973,000	2		1,946,000	973,000	2		1,946,000
1.2 Thickened Sludge Storage Tank																
1)storage Tank Mixer	-				Vertical double paddle φ1.5m×15.0kw				-				Vertical double paddle φ1.5m×15.0kw			
					1,147,000	2		2,294,000					1,147,000	2		2,294,000
2)Sludge Feed Pump	-				-				-				-			
1.3 Sludge Digestion																
1) Digestion Tank Mixer	Self-support mechanical mixer 540m3/H×3.7kw															
	22,962,500	2		45,925,000		-				-				-		
2)Gas Holder	Dry type 300m3															
	40,630,000	2		81,260,000		-				-				-		
3)Desulfurizer	Dry desulfurizer 25m3/H															
	5,221,000	2		10,442,000		-				-				-		
4)Excess Gas Combustion	Furnace combustion type 50m3/Hr															
Equipment	7,350,000	1		7,350,000		-				-				-		
1.4 Sludge Storage Tank																
1)storage Tank Mixer	Vertical double paddle φ1.70m×11.0kw								Vertical double paddle φ1.70m×15.0kw							
	1,592,000	2		3,184,000		-			1,607,000	2		3,214,000				
2)Sludge Feed Pump	Unaxial screw pump φ80mm×20.0m×1.5kw								Unaxial screw pump φ100mm×20.0m×1.5kw							
	823,000	3		2,469,000					948,000	3		2,844,000				
1.5 Sludge Dewatering Equipment																
Dewatering Equipment	Pressuer Insention Screw Press φ500mm×2.3kw								Pressuer Insention Screw Press φ500mm×2.3kw							
	10,750,000	2		21,500,000					10,750,000	2		21,500,000				
Chemical solution tank	Steel cylinder tank 2m3×1.5kw								Steel cylinder tank 3m3×1.5kw							
	1,478,000	2		2,956,000					1,879,000	2		3,758,000				
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw								Unaxial screw pump φ50mm×1.5kw							
	657,500	3		1,972,500					657,500	3		1,972,500				
Chemical feeder	Positive displacement piece feeder 1.0L/min×100L×0.4kw								Positive displacement piece feeder 1.0L/min×100L×0.4kw							
	2,399,000	2		4,798,000					2,399,000	2		4,798,000				
Cake storage hopper	Electric cut gate 3m3×3kw								Electric cut gate 4m3×3kw							
	6,545,000	2		13,090,000					7,195,000	2		14,390,000				
Total				210,331,500				17,625,000				67,807,500				17,625,000
2.Piping-installation cost	It assumes 50 % of the equipment cost.															
	210,331,500	0.5		105,165,750	17,625,000	0.5		8,812,500	67,807,500	0.5		33,903,750	17,625,000	0.5		8,812,500
3.Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.															
	315,497,250	0.4		126,198,900	26,437,500	0.4		10,575,000	101,711,250	0.4		40,684,500	26,437,500	0.4		10575000
Cost of Equipment	Equipment cost+Piping-installation cost+Electric equipment cost															
				441,696,150				37,012,500				142,395,750				37,012,500

Table 8-2-34 Basis for Calculation of Rough Operation Cost 5 (Pd+Pe STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
5.Pd+Pe S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000
②Electricity Rate																
Electric capacity																
Thickened Sludge Collector	0.4	2	0.8		0.4	2	0.8		0.4	2	0.8		0.4	2	0.8	
Thickened Sludge Transfer Pump	3.7	1	3.7		3.7	1	3.7		3.7	1	3.7		3.7	1	3.7	
storage Tank Mixer		-			15	2	30			-			15	2	30	
Sludge Feed Pump		-				-				-				-		
Digestion Tank Mixer	3.7	2	7.4			-				-				-		
subtotal			11.9				34.5				4.5				34.5	
	11.9kw×0.7×24hr×365day				34.5kw×0.7×24hr×365day				4.5kw×0.7×24hr×365day				34.5kw×0.7×24hr×365day			
			72,971				211,554				27,594				211,554	
storage Tank Mixer	11	2	22						15	2	30					
Sludge Feed Pump	1.5	2	3						1.5	2	3					
Dewatering Equipment	2.25	2	4.5						2.25	2	4.5					
Chemical solution tank	1.5	2	3						1.5	2	3					
Chemical feed pump	1.5	2	3						1.5	2	3					
Chemical feeder	0.4	2	0.8						0.4	2	0.8					
Cake storage hopper	3	2	6						3	2	6					
subtotal			42.3								50.3					
	42.3kw×0.7×12.8hr×240day								50.3kw×0.7×12.8hr×240day							
			90,962								108,165					
Electricity Rate(peso/yrs)	10	163,933		1,639,330	10	211,554		2,115,540	10	135,759		1,357,590	10	211,554		2,115,540
③Chemical-dosage cost	22kg/d×365days=		8030						33kg/d×365days=		12045					
(peso/yr)	500	8030		4,015,000					500	12045		6,022,500				
④Rework Cost(peso/yr)	It assumes 2% of the equipment cost.															
	210,331,500	0.02		4,206,630	17,625,000	0.02		352,500	67,807,500	0.02		1,356,150	17,625,000	0.02		352,500
																3,075,540

Table 8-2-35 Basis for Calculation of Rough Equipment Cost 6 (La1 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
6.La1 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
1.Equipment cost																
1.1 Sludge Thickening Facilities																
1)Thickened Sludge Collector	Central drive suspended Pattern φ7.0m×0.4kw				Central drive suspended Pattern φ7.0m×0.4kw				Central drive suspended Pattern φ7.5m×0.4kw				Central drive suspended Pattern φ7.0m×0.4kw			
	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000	8,038,000	2		16,076,000
2)Thickened Sludge Transfer Pump	Unaxial screw pump φ100mm×15.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw			
	884,500	2		1,769,000	1,199,000	2		2,398,000	1,199,000	2		2,398,000	1,199,000	2		2,398,000
1.2 Thickened Sludge Storage Tank																
1)storage Tank Mixer	-				Vertical double paddle φ2.0m×30.0kw				-				Vertical double paddle φ2.0m×30.0kw			
					1,680,500	2		3,361,000					1,680,500	2		3,361,000
2)Sludge Feed Pump	-				-				-				-			
1.3 Sludge Digestion																
1) Digestion Tank Mixer	Self-support mechanical mixer 966m3/H×5.5kw															
	26,696,000	2		53,392,000		-				-				-		
2)Gas Holder	Dry type 500m3															
	48,115,500	2		96,231,000		-				-				-		
3)Desulfurizer	Dry desulfurizer 50m3/H															
	5,221,000	2		10,442,000		-				-				-		
4)Excess Gas Combustion	Furnace combustion type 50m3/Hr															
Equipment	7,350,000	2		14,700,000		-				-				-		
1.4 Sludge Storage Tank																
1)storage Tank Mixer	Vertical double paddle φ1.70m×15.0kw								Vertical double paddle φ1.70m×15.0kw							
	1,560,000	4		6,240,000		-			1,560,000	4		6,240,000				
2)Sludge Feed Pump	Unaxial screw pump φ100mm×20.0m×5.5kw								Unaxial screw pump φ100mm×20.0m×5.5kw							
	895,000	3		2,685,000					895,000	3		2,685,000				
1.5 Sludge Dewatering Equipment																
Dewatering Equipment	Pressuer Insention Screw Press φ700mm×4.1kw								Pressuer Insention Screw Press φ700mm×4.1kw							
	15,950,000	2		31,900,000					15,950,000	2		31,900,000				
Chemical solution tank	Steel cylinder tank 2m3×1.5kw								Steel cylinder tank 4m3×2.2kw							
	1,478,000	2		2,956,000					2,103,000	2		4,206,000				
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw								Unaxial screw pump φ50mm×1.5kw							
	1,542,500	3		4,627,500					1,542,500	3		4,627,500				
Chemical feeder	Positive displacement piece feeder 1.0L/min×100L×0.4kw								Positive displacement piece feeder 2.0L/min×100L×0.4kw							
	2,399,000	2		4,798,000					2,399,000	2		4,798,000				
Cake storage hopper	Electric cut gate 6m3×3kw								Electric cut gate 10m3×3kw							
	8,160,000	2		16,320,000					9,330,000	2		18,660,000				
Total				262,136,500				21,835,000				91,590,500				21,835,000
2.Piping-installation cost	It assumes 50 % of the equipment cost.															
	262,136,500	0.5		131,068,250	21,835,000	0.5		10,917,500	91,590,500	0.5		45,795,250	21,835,000	0.5		10,917,500
3.Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.															
	393,204,750	0.4		157,281,900	32,752,500	0.4		13,101,000	137,385,750	0.4		54,954,300	32,752,500	0.4		13,101,000
Cost of Equipment																
				550,486,650				45,853,500				192,340,050				45,853,500

Table 8-2-36 Basis for Calculation of Rough Operation Cost 6 (La1 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
6.La1 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000
②Electricity Rate																
Electric capacity																
Thickened Sludge Collector	0.4	2	0.8		0.4	2	0.8		0.4	2	0.8		0.4	2	0.8	
Thickened Sludge Transfer Pump	3.7	1	3.7		3.7	1	3.7		3.7	1	3.7		3.7	1	3.7	
storage Tank Mixer		-			30	2	60			-			30	2	60	
Sludge Feed Pump		-				-				-				-		
Digestion Tank Mixer	5.5	2	11			-				-				-		
subtotal			15.5				64.5				4.5				64.5	
	15.5kw×0.7×24hr×365day				64.5kw×0.7×24hr×365day				4.5kw×0.7×24hr×365day				64.5kw×0.7×24hr×365day			
			95,046				395,514				27,594				395,514	
storage Tank Mixer	15	4	60						15	4	60					
Sludge Feed Pump	5.5	2	11						5.5	2	11					
Dewatering Equipment	4.1	2	8.2						4.1	2	8.2					
Chemical solution tank	1.5	2	3						2.2	2	4.4					
Chemical feed pump	1.5	2	3						1.5	2	3					
Chemical feeder	0.4	2	0.8						0.4	2	0.8					
Cake storage hopper	3	2	6						3	2	6					
subtotal			92								93.4					
	92kw×0.7×12.8hr×240day								93.4kw×0.7×12.8hr×240day							
			197,837								200,847					
Electricity Rate(peso/yrs)	10	292,883		2,928,830	10	395,514		3,955,140	10	228,441		2,284,410	10	395,514		3,955,140
③Chemical-dosage cost	49kg/d×365days=		17885						72kg/d×365days=		26280					
(peso/yr)	500	17885		8,942,500					500	26280		13,140,000				
④Rework Cost(peso/yr)	It assumes 2% of the equipment cost.															
	262,136,500	0.02		5,242,730	21,835,000	0.02		436,700	91,590,500	0.02		1,831,810	21,835,000	0.02		436,700

Table 8-2-37 Basis for Calculation of Rough Equipment Cost 7 (La2+Lb2 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
7.La2+Ld2 S.T.P	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money	Unit price	Unit		Amount of money
1.Equipment cost																
1.1 Sludge Thickening Facilities																
1)Thickened Sludge Collector	Central drive suspended Pattern φ7.5m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw				Central drive suspended Pattern φ7.5m×0.4kw				Central drive suspended Pattern φ8.0m×0.4kw			
	8,038,000	3		24,114,000	8,038,000	3		24,114,000	8,038,000	3		24,114,000	8,038,000	3		24,114,000
2)Thickened Sludge Transfer Pump	Unaxial screw pump φ100mm×15.0m×2.2kw				Horizontal nonclogging sludge pump φ100mm×10.0m×2.2kw				Horizontal nonclogging sludge pump φ100mm×10.0m×3.7kw				Horizontal nonclogging sludge pump φ100mm×10.0m×2.2kw			
	1,000,000	3		3,000,000	978,000	3		2,934,000	989,000	3		2,967,000	978,000	3		2,934,000
1.2 Thickened Sludge Storage Tank																
1)storage Tank Mixer	-				Vertical double paddle φ2.5m×37.0kw				-				Vertical double paddle φ2.5m×37.0kw			
					2,954,000	3		8,862,000					2,954,000	3		8,862,000
2)Sludge Feed Pump	-								-							
1.3 Sludge Digestion																
1) Digestion Tank Mixer	Self-support mechanical mixer 1146m3/H×7.5kw															
	28,786,000	3		86,358,000						-						
2)Gas Holder	Dry type 600m3															
	53,860,000	3		161,580,000						-						
3)Desulfurizer	Dry desulfurizer 50m3/H															
	8,222,500	3		24,667,500						-						
4)Excess Gas Combustion	Furnace combustion type 50m3/Hr															
Equipment	7,350,000	3		22,050,000						-						
1.4 Sludge Storage Tank																
1)storage Tank Mixer	Vertical double paddle φ1.70m×15.0kw								Vertical double paddle φ1.70m×15.0kw							
	1,607,000	6		9,642,000					1,607,000	6		9,642,000				
2)Sludge Feed Pump	Unaxial screw pump φ100mm×20.0m×5.5kw								Unaxial screw pump φ100mm×20.0m×5.5kw							
	2,210,500	4		8,842,000					2,210,500	4		8,842,000				
1.5 Sludge Dewatering Equipment																
Dewatering Equipment	Pressuer Insention Screw Press φ700mm×4.1kw								Pressuer Insention Screw Press φ700mm×4.1kw							
	16,850,000	3		50,550,000					66,000,000	3		198,000,000				
Chemical solution tank	Steel cylinder tank 3m3×2.2kw								Steel cylinder tank 5m3×2.2kw							
	1,879,000	3		5,637,000					2,367,500	3		7,102,500				
Chemical feed pump	Unaxial screw pump φ50mm×1.5kw								Unaxial screw pump φ50mm×1.5kw							
	1,542,500	4		6,170,000					1,542,500	4		6,170,000				
Chemical feeder	Positive displacement piece feeder 1.0L/min×100L×0.4kw								Positive displacement piece feeder 2.0L/min×100L×0.4kw							
	2,399,000	3		7,197,000					2,399,000	3		7,197,000				
Cake storage hopper	Electric cut gate 12m3×3kw								Electric cut gate 10m3×3kw							
	9,740,000	2		19,480,000					9,330,000	3		27,990,000				
Total				429,287,500				27,048,000				292,024,500				35,910,000
2.Piping-installation cost	It assumes 50 % of the equipment cost.															
	429,287,500	0.5		214,643,750	27,048,000	0.5		13,524,000	292,024,500	0.5		146,012,250	35,910,000	0.5		17,955,000
3.Electric equipment cost	It assumes 40 % of the equipment cost and piping-installation cost.															
	643,931,250	0.4		257,572,500	40,572,000	0.4		16,228,800	438,036,750	0.4		175,214,700	53,865,000	0.4		21,546,000
Cost of Equipment	Equipment cost+Piping-installation cost+Electric equipment cost															
				901,503,750				56,800,800				613,251,450				75,411,000

Table 8-2-38 Basis for Calculation of Rough Operation Cost 7 (La2+Pb2 STP)

Itemes	Unit Processes according to Purpose:Sludge Thickening-Digestion-Sludge Dewatering								Unit Processes according to Purpose:Sludge Thickening-Sludge Dewatering							
	In case of the on-site approach				In case of the off-site approach				In case of the on-site approach				In case of the off-site approach			
7.La2+Ld2 S.T.P	Unit price	Unit		Amount of mone	Unit price	Unit		Amount of money	Unit price	Unit		Amount of mon	Unit price	Unit		Amount of mone
①Staff Costs(peso/yr)	20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr				20,000peso/mo×12mo＝240,000peso/yr			
	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000	240,000	4	persons	960,000
②Electricity Rate																
Electric capacity																
Thickened Sludge Collector	0.4	3	1.2		0.4	3	1.2		0.4	3	1.2		0.4	3	1.2	
Thickened Sludge Transfer Pump	3.7	2	7.4		2.2	2	4.4		3.7	2	7.4		2.2	2	4.4	
storage Tank Mixer		-			37	3	111			-			37	3	111	
Sludge Feed Pump		-								-						
Digestion Tank Mixer	5.5	3	16.5							-						
subtotal			25.1				116.6				8.6				116.6	
	25.1kw×0.7×24hr×365day				116.6kw×0.7×24hr×365day				8.6kw×0.7×24hr×365day				116.6kw×0.7×24hr×365day			
			153,913				714,991				52,735					
storage Tank Mixer	15	6	90						15	6	90					
Sludge Feed Pump	5.5	3	16.5						5.5	3	16.5					
Dewatering Equipment	4.1	3	12.3						4.1	3	12.3					
Chemical solution tank	2.2	3	6.6						2.2	3	6.6					
Chemical feed pump	1.5	3	4.5						1.5	3	4.5					
Chemical feeder	0.4	3	1.2						0.4	3	1.2					
Cake storage hopper	3	2	6						3	3	9					
subtotal			137.1								140.1					
	137.1kw×0.7×12.8hr×240day								140.1kw×0.7×12.8hr×240day							
			294,820								301,271					
Electricity Rate(peso/yrs)	10	448,733		4,487,330	10	714,991		7,149,910	10	354,006		3,540,060	10	117		1,166
③Chemical-dosage cost	83kg/d×365days=		30295						121kg/d×365days=		44165					
(peso/yr)	500	30295		15,147,500	500	0		0	500	44165		22,082,500	500	0		0
④Rework Cost(peso/yr)	It assumes 2% of the equipment cost.															
	429,287,500	0.02		8,585,750	27,048,000	0.02		540,960	292,024,500	0.02		5,840,490	35,910,000	0.02		718,200

4) Recommendation of Sewage Sludge Management System

(1) Generated Amount of Sludge in the National Capital Region (NCR)

Sewage system construction is being advanced in the NCR in order to improve water quality in the public water body and improve the living environment of citizens. Construction of the sewage system will lead to generation of huge amounts of sludge. Here, the generated amount of sludge is forecast upon dividing the NCR into the area under MWSI jurisdiction and the area under MWCI jurisdiction.

Using the rate of population growth between 2000 and 2007, it is estimated that the population of NCR in 2036 will be 17.3 million. Since the forecast service population of MWSI in 2036 is approximately 9.9 million, the population covered by MWCI will be 7.4 million. The generated amount of sludge will be forecast using this population.

(MWSI sludge quantity)
Design sanitary sewage flow: 1,782,000 m^3/d
Design influent SS concentration: 200 mg/l
Design discharge SS concentration: 50 mg/l
Solids recovery ratio: 85%
Sludge generation rate: 75%
Amount of sludge solids: $1,782,000 \times (200-50) \times 0.75 \times 10^{-6} = 200.5$t/d
Amount of sludge: $200.5 \times 100/(100-99.3) = 28,642.9$ m^3/d
Amount of thickened sludge: $200.5 \times 0.85 \times 100/(100-98.5) = 11,361.7$ m^3/d

(MWCI sludge quantity)
Design sanitary sewage flow: 1,332,000 m^3/d
Design influent SS concentration: 200 mg/l
Design discharge SS concentration: 50 mg/l
Solids recovery ratio: 85%
Sludge generation rate: 75%
Amount of sludge solids: $1,332,000 \times (200-50) \times 0.75 \times 10^{-6} = 149.9$t/d
Amount of sludge: $149.9 \times 100/(100-99.3) = 21,414.3$ m^3/d
Amount of thickened sludge: $149.9 \times 0.85 \times 100/(100-98.5) = 8,494.3$ m^3/d

As can be seen, since it is forecast that huge amounts of sludge will be generated, it will be important to determine how the sludge treatment facilities are situated and how sludge is finally disposed.

(2) Proposal of effective sludge utilization

The current method of final sludge disposal entails directly dewatering the generated sludge and dumping it. However, due to the sheer volume of sludge involved, it is difficult to find disposal sites; moreover, because the sludge dissolves in rain water and groundwater and starts smelling, it is unhygienic and too difficult to handle for use in agriculture.

Anaerobic digestion equipment is installed with the objectives of 1) extending the service life of final disposal sites in line with the reduced capacity of dewatering equipment and reduction of final disposal amounts, 2) stabilizing sludge so that it is easier to dispose, and 3) effectively utilizing energy. Therefore, such equipment is capable of solving the current problems.

Furthermore, sludge drying, composting, sludge incineration and sludge melting are deemed to be inappropriate for the Project because equipment costs are very expensive, product stock yards are required, it is necessary to develop sales routes and so on.

In view of the above points, the best method for effectively utilizing sludge in the Project is thought to be to introduce sludge digestion with the goals of reducing the volume of and stabilizing sludge, land filling the dewatered sludge, or using the sludge in agriculture as soil modifying agent or compost.

(2) Recommendation of Sewage Sludge Management System for Parañaque and Las Piñas

In conclusion, since the sewage sludge treatment system which entails installing sludge thickening equipment at each franchise treatment plant (P-2, 4, 6, and L-A, C, 22) and installing sludge digestion and dewatering equipment at the host treatment plant (P-11) is the most economical, it is proposed for adoption in the Project. As for the type of thickener, gravity thickener is recommended in consideration of economy and maintenance. **Figure 8-2-13** shows the sludge treatment flow in this recommendable case. The flow shows only sludge gas combustion equipment, but fuel battery generation system energized by the sludge digestion gas would be recommended. The electric generation would be produced with output capacity of 200 KWH (final stage) and more to reduce using commercial electricity and it would be possible to reduce necessary stand-by generator capacity. Because of phasing construction schedule recommended, 2 sets of 100KWH generator would be adopted. The Design Parameters of the gas power generator set are as follows

(a) Sewage sludge generation rate in total	1,650m3/d (refer Table 10-8)
(b) Optical power generation rate	9.54MW/d (refer Table 10-10)
(c) Generator out-put	397kw
(d) Power generation efficiency	50%
(e) Rate of power generator	200kw
(f) Number of Gen Set	100kw x 2

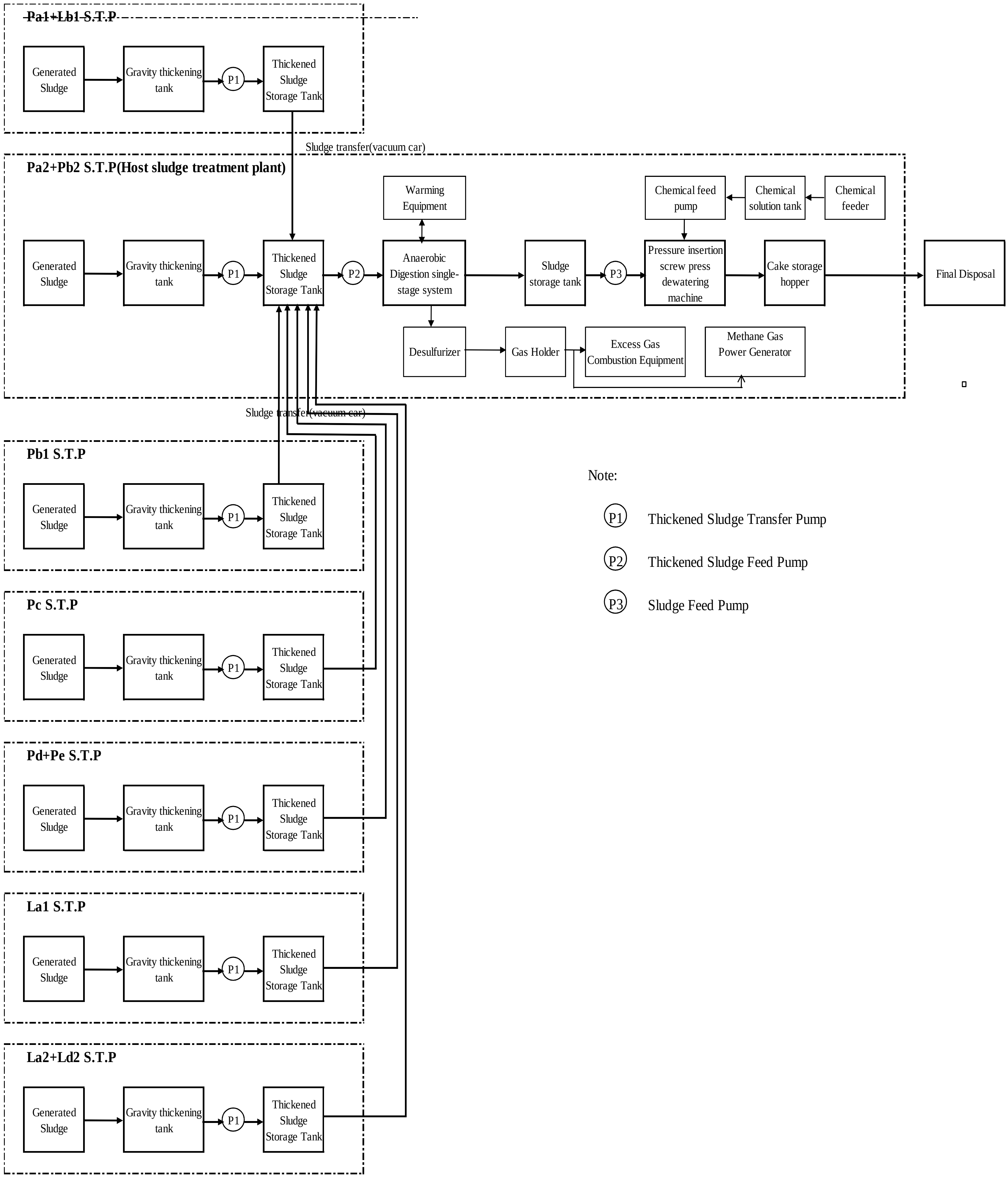
The technical composition, specification and cost estimate are as follows.

Fuel Battery Power Generator	100kw, Digestion gas type, Outdoor use	2 sets
Package components	Fuel package	2 sets
	water treatment unit	
	Nitrogen supplier	
	Exhaust heat exchanger	
	Pre-treatment process (Desulfurization, Reformulation)	
	Boost-up Blower	
Cost	60M Pesos / set	120 MP

Moreover, since it will incur huge cost and take a lot of time to construct the sludge treatment system in the Project, efficient construction work must be implemented. Accordingly, it is proposed that the sludge thickening equipment be constructed at the same time as the sewage treatment facilities, and that dewatering and sludge digestion equipment be expanded in accordance with the phasing construction program implementation.

The generated quantity of sewage sludge will increase in line with the construction of MWSI and MWCI. Since a septage treatment plant will also be constructed, it is possible that septage will be diverted to sewage sludge in the future. Therefore, consideration would be given to separating the treatment of sewage sludge and septage sludge from the MWSI and MWCI and outsourcing it to a third party in the future.

Figure 8-2-13 Flow Sheet of the Proposed Sewage Sludge Treatment System



(3) Sludge Treatment Facilities Construction Plan

See Table 8-3-3 “Project Phased construction plan”.

8.2.6 Sewerage Treatment System Implementation Project

1) Cost Comparison of Alternatives

Comparison of costs is carried out here for the aforementioned treatment district cases and treatment processes. The results are shown in **Table 8-2-39**. Regarding the treatment process in each case, the proposal that combines the OD process and SBR process, which enable the cheapest construction cost, is selected. **Table 8-2-40** shows the detailed construction cost according to each treatment process; **Table 8-2-41** shows the detailed maintenance cost according to each treatment process; and **Table 8-2-42** shows the detailed cost comparison according to each case.

Table 8-2-39 Cost Comparison in Each Case (unit:10^3P)

Table 8-2-39

Item	Case 1	Case 2	Case 4	Case 5	Case 6	Case 7	Case 8
1. Treatment Plant construction cost(*1)	17,214,567	16,201,478	17,118,412	15,660,240	16,488,965	17,118,412	15,660,240
2. Interceptor Construction cost(Includes Conversion Manhole)	4,865,788	4,670,398	4,077,260	4,060,649	4,050,035	4,077,260	4,060,624
3. Pump Station & Manhole Pump Station Construction cost	355,980	352,069	252,395	230,459	229,716	252,395	231,159
4. Treatment plant site preparation cost (P-1)	0	0	270,000	270,000	0	0	0
Sub Total	**22,436,335**	**21,223,945**	**21,718,067**	**20,221,348**	**20,768,716**	**21,448,067**	**19,952,023**
5. Treatment plant site cost	124,800	201,000	810,700	1,396,700	1,197,700	2,061,700	2,647,700
6. Pump Station site cost	89,302	89,302	22,642	7,792	22,642	22,642	7,792
Sub Total	214,102	290,302	833,342	1,404,492	1,220,342	2,084,342	2,655,492
Total	**22,650,437**	**21,514,247**	**22,551,409**	**21,625,840**	**21,989,058**	**23,532,409**	**22,607,515**
7. Pump station maintenance cost (10years)	486,960	464,080	299,310	256,740	271,880	299,310	256,740
8. Treatment plant maintenance cost (10years)	2,043,490	2,204,820	2,133,310	1,881,220	1,998,830	2,133,310	1,881,220

Note 1) Treatment Plant includes sewage treatment process and sludge treatment process.

2) This construction cost doesn't include consultant fees.

3) The cost breakdown of pump stations works out as 40% for civil and construction costs, and 60% for equipment costs.

Table 8-2-40 Detailed Construction Cost by Treatment Method (unit:10^3P)

Case	Treatment District	ID No, Site (ha)	Wastewater (m^3/	OD	CAS	SBR	MBBR	MBR	Note
Case1	Paranaque, Las Pinas ◆	L-C+L-10 (15.60)	266,333	17214567	20657480	17214567	21518209	26854725	
Case2	Paranaque ◆	P-11 (7.62)	163,569	12045538	14454646	12045538	15056923	18791039	
	Las Pinas	L-C+L-10 (15.60)	102,765	4155940	6233910	5194925	6493656	8104083	
	Total		266,334	**16,201,478**	20688556	17240463	21550579	26895122	
Case4	Pa ◆	P-11 (7.62)	87,343	8211370	9853644	8211370	10264213	12809737	
	Pb+Pc	P-1 (4.50)	62,258	3147235	3776682	3147235	3934044	4909687	
	Pd+Pe	P-6 (13.20)	13,968	564882	847324	706103	882629	1101521	
	La1	L-A (3.25)	30,851	1559564	1871477	1559564	1949455	2432920	
	La2+Lb2	L-C (7.00)	71,914	3635361	4362433	3635361	4544201	5671163	
	Total		266,334	**17,118,412**	20711560	17259633	21574541	26925027	
Case5	Pa1+Lb1	L-22 (19.00)	38,910	1573567	2360351	1966959	2458699	3068456	
	Pa2+Pb2 ◆	P-11 (7.62)	77,028	7692525	9231030	7692525	9615656	12000339	
	Pb1	P-4 (8.80)	28,845	1166526	1749790	1458158	1822698	2274726	
	Pc	P-1 (4.50)	24,799	1002902	1504352	1253627	1567034	1955658	
	Pd+Pe	P-6 (13.20)	13,968	564882	847324	706103	882629	1101521	
	La1	L-A (3.25)	30,851	1559564	1871477	1559564	1949455	2432920	
	La2+Lb2	L-C (7.00)	51,934	2100274	3150410	2625342	3281678	4095534	
	Total		266,335	**15,660,240**	20714734	17262278	21577849	26929154	
Case6	Pa ◆	P-11 (7.62)	87,343	8211370	9853644	8211370	10264213	12809737	
	Pb+Pc	P-4 (8.80)	62,258	2517788	3776682	3147235	3934044	4909687	
	Pd	P-6 (13.20)	13,968	564882	847324	706103	882629	1101521	
	La1	L-A (3.25)	30,851	1559564	1871477	1559564	1949455	2432920	
	La2+Lb	L-C (7.00)	71,914	3635361	4362433	3635361	4544201	5671163	
	Total		266,334	**16,488,965**	20711560	17259633	21574541	26925027	
Case7	Pa ◆	P-11 (7.62)	87,343	8211370	9853644	8211370	10264213	12809737	
	Pb+Pc	P-2 (4.20)	62,258	3147235	3776682	3147235	3934044	4909687	
	Pd+Pe	P-6 (13.20)	13,968	564882	847324	706103	882629	1101521	
	La1	L-A (3.25)	30,851	1559564	1871477	1559564	1949455	2432920	
	La+Lb	L-C (7.00)	71,914	3635361	4362433	3635361	4544201	5671163	
	Total		266,334	**17,118,412**	20711560	17259633	21574541	26925027	
Case8	Pa1+ Lb1	L-22 (19.00)	38,910	1573567	2360351	1966959	2458699	3068456	
	Pa2+Pb2 ◆	P-11 (7.62)	77,028	7692525	9231030	7692525	9615656	12000339	
	Pb1	P-4 (8.80)	28,845	1166526	1749790	1458158	1822698	2274726	
	Pc	P-2 (4.20)	24,799	1002902	1504352	1253627	1567034	1955658	
	Pd+Pe	P-6 (13.20)	13,968	564882	847324	706103	882629	1101521	
	La1	L-A (3.25)	30,851	1559564	1871477	1559564	1949455	2432920	
	La2+Lb2	L-C (7.00)	51,934	2100274	3150410	2625342	3281678	4095534	
	Total		266,335	**15,660,240**	20714734	17262278	21577848	26929154	

Note: 1.Red lettering indicates selection of SBR because OD cannot fit. 2. ◆means the STPs where Sludge treatment process installed.

Note

1. Treatment plant construction costs are based on the SBR process and assume current market prices in the Philippines. Other treatment plant construction costs have been calculated upon considering civil engineering and construction costs, etc. in the Philippines.

2. ◎ indicates the sludge treatment facility site. The sludge treatment facilities are expected to cost 28.5% of the overall construction cost. The remaining treatment plant is thickening facilities. The sludge treatment facilities have been designed in reference to Japanese Guidelines for General Planning and Survey of Basin Sewerage Systems.

Table 8-2-41 Detailed Annual Maintenance Cost by Treatment Method (unit:10^3P)

Alternative Case No.	Treatment District Name	ID No	Caoacity (m^3/d)	OD (Pesos/Y)	CAS (Pesos/Y)	SBR (Pesos/Y)	MBBR (Pesos/Y)
Case1	Paranaque,Las Pinas	L-C+L-10	266,334	204,349	290,641	204,349	261,877
Case2	Paranaque	P-11	163,569	161,989	161,989	161,989	161,989
	Las Pinas	L-C+L-10	102,765	58,493	113,986	80,690	102,888
	Total		266,334	220,482	275,975	242,679	264,877
Case 4	Pa	P-11	87,343	69,031	97,330	69,031	87,897
	Pb+Pc	P-1	62,258	50,067	70,239	50,067	63,515
	Pd+Pe	P-6	13,968	10,543	18,085	13,560	16,577
	La1	L-A	30,851	26,323	36,319	26,323	32,987
	La2+Lb	L-C	71,914	57,367	80,667	57,367	72,900
	Total		Total	213,331	302,641	216,349	273,877
Case 5	Pa1+Lb1	L-22	38,910	24,011	45,023	32,416	40,821
	Pa2+Pb2	P-11	77,028	61,233	86,190	61,233	77,871
	Pb1	P-4	28,845	18,576	34,153	24,807	31,037
	Pc	P-1	24,799	16,391	29,783	21,748	27,105
	Pd+Pe	P-6	13,968	10,543	18,085	13,560	16,577
	La1	L-A	30,851	26,323	36,319	26,323	32,987
	La2+Lb2	L-C	51,934	31,044	59,089	42,262	53,480
	Total		Total	188,121	308,642	222,349	279,878
Case 6	Pa	P-11	87,343	69,031	97,330	69,031	87,897
	Pb+Pc	P-4	62,258	36,619	70,239	50,067	63,515
	Pd+Pe	P-6	13,968	10,543	18,085	13,560	16,577
	La1	L-A	30,851	26,323	36,319	26,323	32,987
	La2+Lb	L-C	71,914	57,367	80,667	57,367	72,900
	Total		Total	199,883	302,641	216,349	273,877
Case 7	Pa	P-11	87,343	69,031	97,330	69,031	87,897
	Pb+Pc	P-2	62,258	50,067	70,239	50,067	63,515
	Pd+Pe	P-6	13,968	10,543	18,085	13,560	16,577
	La1	L-A	30,851	26,323	36,319	26,323	32,987
	La2+Lb	L-C	71,914	57,367	80,667	57,367	72,900
	Total		Total	213,331	302,641	216,349	273,877
Case 8	Pa1+Lb1	L-22	38,910	24,011	45,023	32,416	40,821
	Pa2+Pb2	P-11	77,028	61,233	86,190	61,233	77,871
	Pb1	P-4	28,845	18,576	34,153	24,807	31,037
	Pc	P-2	24,799	16,391	29,783	21,748	27,105
	Pd+Pe	P-6	13,968	10,543	18,085	13,560	16,577
	La1	L-A	30,851	26,323	36,319	26,323	32,987
	La2+Lb2	L-C	51,934	31,044	59,089	42,262	53,480
	Total		Total	188,121	308,642	222,349	279,878

Note)1. Red lettering in the table indicates selection of SBR.

Table 8-2-42 Detailed Cost Comparison by Case (unit:10^3P)

Item	Case 1		Case 2		Case 4		Case 5		Case 6		Case 7		Case 8	
	ID No	Cost	ID No	Cost	ID No	Cost	ID No	Cost	ID No	Cost	ID No	Cost	ID No	Cost
1. Treatment Plant Construction Cost	(L-C+L-10)	17,214,567	(P-11)	12,045,538	(P-11)	8,211,370	(L-22)	1,573,567	(P-11)	8,211,370	(P-11)	8,211,370	(L-22)	1,573,567
			(L-C+L-10)	4,155,940	(P-1)	3,147,235	(P-11)	7,692,525	(P-4)	2,517,788	(P-2)	3,147,235	(P-11)	7,692,525
					(P-6)	564,882	(P-4)	1,166,526	(P-6)	564,882	(P-6)	564,882	(P-4)	1,166,526
					(L-A)	1,559,564	(P-1)	1,002,902	(L-A)	1,559,564	(L-A)	1,559,564	(P-2)	1,002,902
					(L-C)	3,635,361	(P-6)	564,882	(L-C)	3,635,361	(L-C)	3,635,361	(P-6)	564,882
							(L-A)	1,559,564					(L-A)	1,559,564
							(L-C)	2,100,274					(L-C)	2,100,274
Sub Total	**17,214,567**		**16,201,478**		**17,118,412**		**15,660,240**		**16,488,965**		**17,118,412**		**15,660,240**	
2. Interceptor Construction Cost ※1		5,069,385		5,001,480		4,313,809		4,060,624		4,318,432		4,313,809		4,233,124
3. Pump Station Construction Cost		184,180		180,269		72,700		58,659		87,500		81,659		58,659
4. Site Reclaim Cost(P-1)		0		0		270,000		270,000		0		0		0
Sub Total		5,253,565		5,181,749		4,656,509		4,389,283		4,405,932		4,395,468		4,291,783
Total (A)	**22,468,132**		**21,383,227**		**21,774,921**		**20,049,523**		**20,894,897**		**21,513,880**		**19,952,023**	
5. Land Procurement Cost (STP)	(L-C+L-10)	124,800	(P-11)	76,200	(P-11)	76,200	(L-22)	190,000	(P-11)	76,200	(P-11)	76,200	(L-22)	190,000
			(L-C+L-10)	124,800	(P-1)	9,000	(P-11)	76,200	(P-4)	396,000	(P-2)	1,260,000	(P-11)	76,200
					(P-6)	528,000	(P-4)	396,000	(P-6)	528,000	(P-6)	528,000	(P-4)	396,000
					(L-A)	162,500	(P-1)	9,000	(L-A)	162,500	(L-A)	162,500	(P-2)	1,260,000
					(L-C)	35,000	(P-6)	528,000	(L-C)	35,000	(L-C)	35,000	(P-6)	528,000
							(L-A)	162,500					(L-A)	162,500
							(L-C)	35,000					(L-C)	35,000
Sub Total	**124,800**		**201,000**		**810,700**		**1,396,700**		**1,197,700**		**2,061,700**		**2,647,700**	
6. Land Procurement Cost (PS)		89,024		85,724		19,064		7,792		19,064		19,064		7,792
Land Procurement Cost Total (B)		213,824		286,724		829,764		1,404,492		1,216,764		2,080,764		2,655,492
Total (A)+(B)	**22,681,956**		**21,669,951**		**22,604,685**		**21,454,015**		**22,111,661**		**23,594,644**		**22,607,515**	
7. Pump Station Maintenance Cost(10 years)		486,960		464,080		299,310		256,740		322,230		299,310		256,740
8. Treatment Plant Maintenance Cost (10years)	(L-C+L-10)	2,043,490	(P-11)	1,619,890	(P-11)	690,310	(L-22)	240,110	(P-11)	690,310	(P-11)	690,310	(L-22)	240,110
			(L-C+L-10)	584,930	(P-1)	500,670	(P-11)	612,330	(P-4)	366,190	(P-2)	500,670	(P-11)	612,330
					(P-6)	105,430	(P-4)	185,760	(P-6)	105,430	(P-6)	105,430	(P-4)	185,760
					(L-A)	263,230	(P-1)	163,910	(L-A)	263,230	(L-A)	263,230	(P-2)	163,910
					(L-C)	573,670	(P-6)	105,430	(L-C)	573,670	(L-C)	573,670	(P-6)	105,430
							(L-A)	263,230					(L-A)	263,230
							(L-C)	310,440					(L-C)	310,440
Sub Total	**2,530,450**		**2,668,900**		**2,432,620**		**2,137,950**		**2,321,060**		**2,432,620**		**2,137,950**	

Note) ※1 (Includes Manhole Pump & Conversiuon Manhole)

Note

1. Red lettering for the treatment plant construction cost indicates the OD process, while black lettering indicates the SBR process.
2. The interceptor construction cost includes the force main, gravity main and conversion manhole.
3. The pump construction cost includes pump station and manhole pump.
4. ※[1] Includes Manhole Pump & Conversion Manhole.
5. This construction cost doesn't include consultant fees.

2) Recommendable Sewerage System Plan for Project Areas

As is shown in the general comparison of each case in T**able 8-2-39**, scores have been given and rankings determined based on comparing construction cost, compatibility with the treatment plant candidate sites, and technical items. Case 8 is recommended because this offers the cheapest construction cost and is also the most advantageous option in terms of overall ranking.

Table 8-2-43 shows unit cost comparison of Case 8 with past project costs (Sewage Treatment Process Cost Comparison)

Table 8-2-43 Unit Cost Comparison of STP Construction

Status		STP Site	Process	Capacity m^3/d	Cost MP	Cost/m^3 P	Average Cost by Process P/m^3	Total Average Cost P/m^3
MMSSIP	Paranaque/Las Pinas	P-11	SBR	77,028	3,361.9	43,646	43,336	38,990 (100%)
		L-A		30,851	1,327.4	43,026		
		L-22	OD	38,910	1,472.6	37,846	37,252	
		L-C		51,934	1,990.0	38,318		
		P-2		24,799	920.4	37,115		
		P-4		28,845	1,076.7	37,327		
		P-6		13,968	498.0	35,655		
Past Bidding Results	Existing Project constructed in 5 Yrs	Paltok	MBBR	4,900	182.0	37,143	45,841	36,841 (94%)
		San Antonio		3,310	171.0	51,662		
		Del Monte		3,510	171.0	48,718		
		Samson 2	IFAS	1,900	70.0	36,842	42,588	
		Tandang Sola		1,200	58.0	48,333		
		Bagbag	SBR	10,400	223.0	21,442	24,009	
		Dona Imelda		9,400	226.0	24,043		
		Tatalon		8,100	215.0	26,543		
		Bahay Toro	AOSR	13,400	267.0	19,925	19,925	19,925
		Paco	Jokaso	410	28.0	68,293	68,293	68,293

SBR: Sequential Batch Reactor, OD: Oxygen Ditch, MBBR: Moving Bio-bed Reactor,

IFAS: Integrated Fix-film Activated Sludge , AOSR: Activated Oxygen Sludge Reactor, Jokaso: Modular Type Bio Reactor

The final contract costs of existing STPs are the result of international competitive bids, thus should be lower than cost estimate for budgeting process conducted in the project design. OD cost is about 86% of SBR. If SBR cost in this project is assumed as the same price of existing SBR bid results, say 24,000P/m^3, OD might be 20,600P/m^3. Each bid has different situation, thus simple comparison of process with the existing cost is just for reference.

8.3 Recommendation of Implementation Plan of Sewerage System Project Components

8.3.1 Project Description

The Project can broadly be divided into sewer facilities and treatment facilities, and the sewer facilities include conversion manholes, interceptors, manhole pumps and pump stations.

1) Storm Overflow Chambers and Interceptor

The storm overflow chambers, which separate storm water and sanitary sewage from the existing outfall sewers, will be installed near the outfalls from the existing sewers to the creeks. The separated sanitary sewage will be diverted to the downstream treatment facilities by interceptor sewers.

2) Manhole Pump Stations

This district has a grade difference of approximately 2~3 m with the route taken by creeks and interceptor sewers, and since sewers can be buried to a shallow depth and construction cost can be reduced, manhole pumps will be installed as integrated structures with the storm overflow chambers installed near the sanitary sewage outfalls. Manhole pumps, which are simple structures comprising pumps installed in manholes, will be installed in 84 locations.

3) Pump Stations

Since pump stations will be based on gravity flow, meaning that excavation depths will become deep depending on the terrain. pump stations will be installed in appropriate locations. Pump stations will be constructed in three locations.

4) Treatment Plants

The sanitary sewage collected by the interceptors will be treated by the OD process and SBR process, which are cheap and easy to maintain, and the treated sewage will be discharged via creeks and rivers into Manila Bay. The sludge treatment facilities will be consolidated into one place.

The sludge generated in each treatment plant will be thickened in sludge thickening tanks and transported by vacuum truck to the P-11 plant in Parañaque, where it will undergo intensive treatment and will be finally disposed as dry cake. The sludge treatment facilities will be consolidated into one place.

8.3.2 Land Acquisition Plan

1) Proposed Candidate Sites for the Plants

   As described above, the project components basically consist of sewage treatment plants with sewage sludge treatment process, pumping stations, and sewer collection system including manhole pumps. The sewer collection facilities will be installed underground of roads or streets running near waterways (creeks, rivers, and esteros), however sewage treatment plants and pumping stations require plant installation sites, thus, necessary land acquisition plan should be made.

2) Candidate Sites and Land Owners

   The candidate lands have been invested in the project sites to comply with technical requirements, that is, sufficient area space to accommodate necessary facilities, locations to be at downstream of waterways or as nearer the positions as possible to apply more gravity collection sewer systems, vacant and possible to be sold.

   The candidate sites to be selected are shown in appendix 1.

The land procurement costs are calculated with Candidate site information that was collected by the survey team. **Table 8-3-1** shows the working process for the team to collect the candidate sites' information. **Table 8-3-2** shows the information list of candidate sites, showing the land owners, address, tax declaration values, etc.

Table 8-3-1 Sequence in the Identification & Data/Documents of the Proposed STP Sites

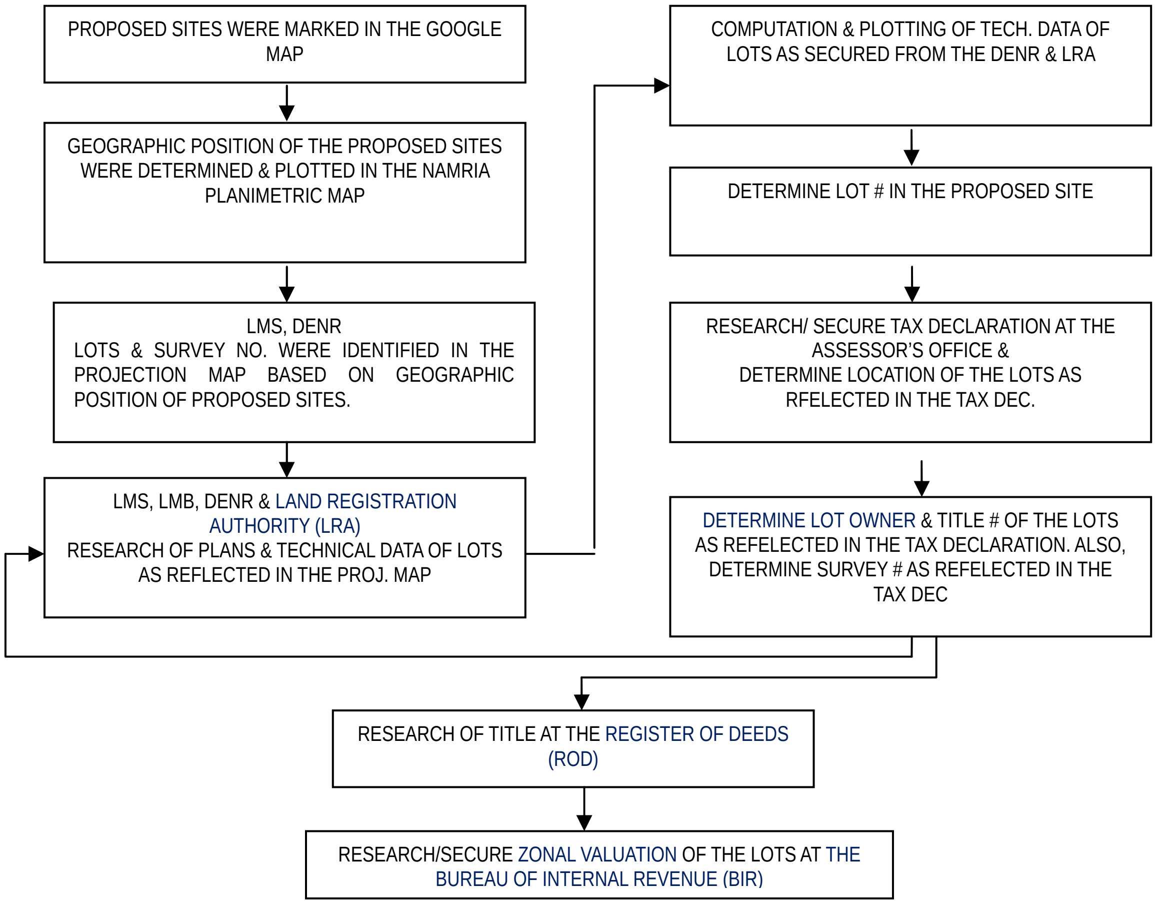


Table 8-3-2 Candidate Sites' Information (Parañaque and Las Piñas)

SITE	LOCATION	PLAN & SURVEY NUMBER	TAX DECLARATION	TCT NO.	OWNER	MARKET VALUE PER TAX DEC. (IN PESOS/SQ.M.)	ZONAL VALUE	REMARKS
P-1	DONGALO, PARAÑAQUE CITY	Csd-00-1001398, AP-18882, Psd-00-067485, Psu-120184 (Amd.) Psu-162338 (Amd.), Ap-10380, Pcs-351, Psu-165119, Ap-16717 Psu-165119, (LRC) Psd-43815 Ap-9969	E-013-05325 E-013-05326 E-103-05327	175795 175798 175789	LOMBOS, ESTELLA P ET AL	200.00 200.00 200.00	4,500.00 4,500.00 4,500.00	
P-2	Brgy. Ibayo, Parañaque City	Psu-100709 (Lot 3314) Pcs-04-000391 SK-00-000633 Psu-120185 (Lot 3012) Psu-53000 (Lot 3130, 3124, 3123) (LRC) Pcs-1206 (LRC) Psd-115961			Francisca Bautista, et.al.	30,000.00	50,000.00	Tax Dec. for release @ Parañaque Assessor's Office
P-3	LA HUERTA, PARAÑAQUE CITY	Pcs-00-008650, (LRC) Pcs-28052	E-008-18891	155928	GLOBAL EQUITIES INC.	700.00	12,000.00	
P-4	IBAYO, PARAÑAQUE CITY	Psu-123840, Ap-04-000157, Ap-9157, Ap-9137, (LRC) Psd-197642,Pcs-00-008994, Pcs-00-010272, Psd-00-071193 Psu-110176, Pcs-13-000199, Psu-173068-D			NAIA Property (Civil Aeronautics Administration)		4,500.00	Research of Tax Declaration is still on-going
p-6	PARAÑAQUE CITY	Pcs-13-002177, REL-00-000016	E-004-03326	173511	LNC (SPV-AMC) CORPORATION,	4,000.00	40,000.00	

			E-004-03766 E-004-03767 E-004-04143 E-004-03106	177677 177674 181203 168946	OPAL PORTFOLIO INVESTMENTS (SPV-AMC) INC., MANILA BAY BLUEWATER DEVELOPMENT, CORPORATION LEGACY VENTURES REALTY AND DEVELOPMENT INC.	4,000.00 4,000.00 4,000.00	40,000.00 40,000.00 40,000.00	
P-11	Brgy. La Huerta & San Dionisio, Parañaque City	Psu-142316 Lots 4186, 4306, 4307, 2831 (Case-3) Pcs-13-001647 Pcs-00-008964 Rel-00-000860 Lots 4977, 4976, 4978, 4168 Lots 4076, 4079, 5082, 4167 (LRC) Psd-314787			Francisco Felipe Gonzales	1,000.00	7,500.00	Tax Dec. for release @ Parañaque Assessor's Office
P-12	SAN DIONISIO, PARAÑAQUE CITY	Psu-142101, Ap-20752, Psu-14836, Psu-14236, Psd-00-056398 Cad. Lot 4165, 4166, Parañaque Cad. Case 4	E-008-06688 E-008-14425 E-008-06689	OCT 240 OCT 312	PASCUAL ET AL. LEONARDO VELARDE, MARIANO Z. RODROGUEZ,	840.00 400.00 840.00	7,000.00 7,000.00 7,000.00	

					CARMEN S.			
L-A	PAMPLONA UNO, LAS PIÑAS CITY	A-3-B-4-B, PSD-29031	E-009-05924	T-111103	VAA BUILDERS CORP.	5,000.00	25,400.00	
L-C	MANUYO UNO, LAS PIÑAS CITY	PSU-43709, PSU-13777, BLK. 6	E-004-01759 E-001-02575	T-78061, 233865	ADELFA PROPERTIES, INC., ADELA & MAXIMA FERRER	200.00, 800.00	2,500.00	Two or more Adjoining lots.. Tqx Dec. sampling only.., Number of included lots to be determined later after securing the title & plotting of plans
L-6	PULANG LUPA UNO, LAS PIÑAS	PSU-200768	E-005-00571	T-6720	GOLDEN HAVEN MOEMORIAL PARK	1,500.00	3,100.00	
L-22	BF INT'L, LAS PIÑAS CITY	3-B, PSD-007601-025955-D, 1-D-2, PSD-007601-028242-D	E-018-03735 E-012-05250 E-001-08371 E-001-26791 E-001-26790 E-001-26789 E-001-27652 E-001-28205 E-001-28204 E-001-27654	T-39110, T-64050 144512 144511 144513 147545 S-33640 S-33640	HOME INSURANCE & GUARANTY CORP. AGUIRRE, TOMAS B. LAND BANK OF THE PHILIPPINES LUCAS, RUFINO S. & DEBBIE N SPS BF HOMES INC SAULER, AMANDO R.	1,500.00, 1,500.00 1,000.00 700.00 700.00 700.00 1,000.00 1,000.00 1,000.00 4,028.190	2,600.00	Two or more Adjoining lots.. Tqx Dec. sampling only.., Number of included lots to be determined later after securing the title & plotting of plans

PS-1	LA HUERTA, PARAÑAQUE CITY	Pcs-00-007786	E-013-04945 E-013-04946	80041	CORNEJO, LAURA H. HERNANDEZ, CELESTINO, et al	1,000.00 1,000.00	7,500.00 7,500.00	
PS-2	TALON DOS, LAS PIÑAS CITY	LOT 21, BLK. 7, PSD-04-003785, LOT 10, BLK. 43, PCS-14212	E-014-27515 E-017-08755	T-108773, T-108472	NAVARETTE, JUANITO B.	1,500.00, 1,300.00	2,500.00	Two or more Adjoining lots.. Tqx Dec. sampling only.., Number of included lots to be determined later after securing the title & plotting of plans
PS-3	TALON CINCO, LAS PIÑAS CITY	LOT 7 & 12, BLK. 4, PCS-1664	E-017-07306, E-017-12269	T-11507, 101213	MANUELA CORPORATION	800.00, 800.00	2,100.00	
PS-6	TALON CINCO, LAS PIÑAS CITY	1-B-2-A-1, PSD-00-074670	E-017-19841	T-110087	DIVERSIFIED HOLDINS, INC.	2,000.00	2,400.00	
PS-4	PULANG LUPA DOS, LAS PIÑAS, CITY	1-B, PSD-287465	E-008-05039	T-37921	PASCUAL, ALFREDO, ET AL	1,500.00	2,600.00	

NOTES:

1) TAX DECLARATION OF SITES SITUATED IN PARAÑAQUE CITY WILL BE AVAILABLE ON THE FIRST WEEK OF JANUARY 2011 PER CITY ASSESSOR OF PARAÑAQUE CITY.
2) TITLE OF SITES IN THE ABOVE SITES (PARAÑAQUE CITY) WILL BE IDENTIFIED AFTER WE SECURED THE TAX DEC.
3) ZONAL VALUE OF THE ABOVE SITES (PARAÑAQUE CITY) CAN BE SECURED AT THE BIR AFTER WE SECURED TAX DEC FROM THE ASSESSOR'S OFFICE.
4) DOCUMENTS ALREADY SECURED;
   - FOR PARAÑAQUE CITY;
     - PHOTO COPY OF PLANS FROM THE DENR & LRA
   - FOR LAS PIÑAS CITY;
     - PHOTO COPY OF PLANS FROM DENR & LRA
     - CERTIFIED TRUE-COPY OF TAX DECLARATION
     - CERTIFIED ZONAL VALUE FROM THE BIR
5) PSD – SUBDVISION SURVEY OF TITLED PROPERTY

PCS – CONSOLIDATION & SUBDIVISION SURVEY OF TITLED PROPERTIES
REL – RELOCATION SURVEY
CSD – SUBDIVISION SURVEY OF UNDECREED OR UNTITLED PROPERTIES
PSU – ISOLATED/ ORIGINAL SURVEY OF PARCEL OF LAND
AP – ADVANCE PLAN OF CADASTRAL LOTS

SUBMITTED BY:
G.P. ARTIEDA SURVEYING OFFICE
AS OF 23 DEC. 2010

3) Recommended Candidate Site Information

Sewerage system alternative case 8 is recommended through the selection process described in former sections. The lands information of sewerage treatment system plants and pumping stations is reviewed hereunder (**Table 8-3-3**).

Table 8-3-3 Candidate Site Information

Plant	Area 1,000M^3	Owner	Tax Dec. Value Peso/M^3	Condition
P-2	42	Francisca Bautista, et.al.	30,000	Vacant
P-4	88	NAIA Property (Civil Aeronautics Administration)	4,500	Do
P-6	132	LNC (SPV-AMC) Corporation,	4,000	Do
P-11	76.2	Francisco Felipe Gonzales	1,000	Do
L-A	32.5	VAA BUILDERS Corp.	5,000	Do
L-C	70	ADELFA PROPERTIES, INC., ADELA & MAXIMA FERRER	200 800	Do
L-22	190	HOME INSURANCE & GUARANTY CORP. AGUIRRE, TOMAS B. LAND BANK OF THE PHILIPPINES LUCAS, RUFINO S. & DEBBIE N SPS BF HOMES INC, SAULER, AMANDO R.	700～4,000	Do
PS-2	0.544	NAVARETTE, JUANITO B.	1300/1500	Do
PS-4	2.040	PASCUAL, ALFREDO, ET AL	1,500	Do
PS-6	1.988	DIVERSIFIED HOLDINS, INC.	2,000	Do

4) Land Acquisition Plan

The land procurement in the project areas is essential to establish sewerage treatment system in Parañaque and Las Piñas. As conclusion of careful study on sewage and sludge treatment plant process, collection line installation plan, and relevant management programs, seven sewage and sludge treatment plants and three pumping stations are recommended. In order to realize the recommendable plans, available and viable candidate plant sites were selected for the plant construction.

Sewerage system should be designed to use gravity flow systems as much as possible, and sewage catchment areas should better be divided into sub-basin area locations, the plant site selection would be restricted in the locations. The survey team found total 43 candidate sites for sewage treatment plants, and 6 candidate sites for pumping stations. In those candidate sites, finally 7 STP sites and 3 PS sites were selected in all aspects of availability, area accommodation, geographical location, ease to construct and operate the systems, economical and effective land procurement, etc.

Because of viability of land acquisition and easy construction, the final selection was made taking consideration that all candidate lands are kept by private or corporation ownership, there are not any residents, houses, facilities, buildings, nor materials stored in the lands. Most of all site candidate lands are perfectly reclaimed vacant lands and well managed/protected from outsiders The land areas selected are shown in **Table 8-3-4** (Refer appendix 1, site pictures).

Table 8-3-4 Candidate Sites Selected

STP Location	Area Size (ha)	Land Condition	Land Cost (Market Value)
P2	4.2	Vacant	1,260,000
P4	8.8	Do	396,000
P6	13.2	Do	528,000
P11	7.62	Do	76,200
LA	3.25	Do	162,500
LC	7.0	Do	35,000
L22	19.0	Do	190,000
PS Location	**Area Size (m^2)**	**Land Condition**	
PS1	4,795	Vacant	3,976
PS2	544	Do	756
PS3	457	Do	3,060

.

(1) Budgetary Plan for Buying Lands

All selected lands are just kept by the land owners without any future use plan at this moment and being maintained for selling. Thus the land acquisition could be made through ordinal business transaction to transfer officially the land owner record and registration from those owners to MWSI when they reach agreement to the price.

The site lands would be bought before each phase of project implementation starts, the budgetary schedule should be incorporated in MWSI revised business plan to year 2037, termination year of their concessionaire agreement, and annual finance program should include the land acquisition budget for the project construction phase to be commenced in the next year.

(2) Resettlement caused by Land Procurement

As described in the above, any involuntary resettlement won't be raised. Confirmation items for land procurement are made subject to OP 4.12, the World Bank, December, 2011. Identification follows Abbreviated Resettlement Plan as follows.

a) Necessity of the lands and resettlement;
The land procurement will be essential to construct sewerage treatment system in Parañaque and Las Piñas Cities as described above. As all candidate lands are vacant and kept by private or corporation ownership, there are not any residents, houses, facilities, buildings, nor materials stored in the lands, .therefore resettlement plan is not required for these perfect vacant lands without any future use plan by owner(s).

b) Results of population census and property and land survey targeting all occupants of the target areas;
The targeting lands are owned by total 15 private or corporate owners, and perfectly vacant.

Land area sizes and tax declaration values are shown in **Table 8-3-4.**

c) Results of household budget and livelihood survey targeting at least 20% of the occupants of the target area;
There are no occupants on the land, the owners are not conducting cultivation (not earning a livelihood off the land), and therefore there will be no impact on the household budget and livelihood survey.

d) Requisites for recipients of lost property compensation and household budget and livelihood rebuilding measures;
Since the land targeted for acquisition here is not farmland or rental land and isn't used for other activities, there will be no impact on the livelihood of the land owners

e) Compensation procedure for lost assets based on total reacquisition cost, in consideration of survey of reacquisition prices;
Since the target land will be transferred from the current owner(s) to MWSI through pure business transaction, any compensation prices and compensation procedure with respect to persons suffering the above property losses will not be required.

f) Livelihood rebuilding measures geared to improving or at least restoring the living standard of recipients compared to before resettlement, in consideration of the findings of the needs survey regarding livelihood rebuilding measures;
Negative, because there are no persons eligible for livelihood rebuilding measures as described in item d)

g) Authority of the claim handling organization, and claim handling procedure;
As far as the business transaction between the land owners and MWSI should follow the related lows and business practices, any conflict raised through the business activities shall be resolved among the parties, However, Program Managing Group (PMG) in MWSI Project Planning Department is responsible for addressing any grievance redress caused by the land acquisition activities and/or post land acquisition, thus they join the land procurement negotiation and before or during the negotiation, they conduct explanatory meetings with residents and/or any affected personnel by the land acquisition. At pre and post land acquisition stage, PMG should address any grievance, but the grievance during construction shall be addressed by the Construction Group in the Department.

h) Identification and duties of agencies (implementing agency, local government, consultant, NGOs, etc.) responsible for resettlement of residents;
MWSI is a responsible agency to procure the necessary lands. Land Management Sector (LMS), Land Management Bureau (LMB), Land Registration Authority (LRA), Register of Deeds (ROD), and Bureau of Internal Revenue (BIR) are related agencies.

i) Implementation schedule for starting the physical resettlement following completion of compensation payments for lost property;
Not applicable.

j) Costs and finances;
The land procurement shall be covered by MWSI budget schedule. Total value of the budget should cover at least the present market value shown in **Table 8-3-4**

k) Monitoring setup and monitoring form of the implementing agency:
Subject to item g).

l) Initial design and results of resident consultations concerning alternative plans for livelihood rebuilding measures;
Not required.

8.3.3 Breakdown of Project Cost Estimates

Table 8-3-5 shows construction cost (not including detail engineering cost) in each of the seven treatment districts. In terms of construction cost breakdown, treatment facilities account for 7.1 percent and interceptors for 18.7 percent.

Table 8-3-5 Construction Cost in Each Treatment District Unit:1,000P

	Pa1+Lb1	Pa2+Pb2	Pb1	Pc	Pd+Pe	La1	La2+Lb2	Total
ID No	L-22	P-11	P-4	P-2	P-6	L-A	L-C	
1.STP	2,129,470	4,981,733	1,575,816	1,357,214	766,475	1,996,345	2,853,187	15,660,240
2.Pump Stations	22,006					14,647	22,006	58,659
3.Manhole Pump	33,700	57,600	5,700	5,500		29,400	40,600	172,500
4.Force Main Pipe	37,906	93,061	5,026	2,457		83,475	55,204	277,129
5.Interceptor(Gravity)	481,210	996,216	511,072	284,464	159,484	457,998	740,412	3,630,856
6.Conversion Manhole	21,350	43,708	15,520	10,457	1,183	15,442	44,979	152,639
Sub Total	**2,725,642**	**6,172,318**	**2,113,134**	**1,660,092**	**927,142**	**2,597,307**	**3,756,388**	**19,952,023**
7.Land Procurement(STP)	190,000	76,200	396,000	1,260,000	528,000	162,500	35,000	2,647,700
8.Land Procurement(PS)	398					756	3,060	4,214
Sub Total	**190,398**	**76,200**	**396,000**	**1,260,000**	**528,000**	**163,256**	**38,060**	**2,651,914**
Total	**2,916,040**	**6,248,518**	**2,509,134**	**2,920,092**	**1,455,142**	**2,760,563**	**3,794,448**	**22,603,937**

8.3.4 Project Scope

1) Project Scope

① Design treatment area Parañaque: 4,544.01 ha, Las Piñas: 3,190.0 ha
② Design treatment population Parañaque: 740,871, Las Piñas: 652,737
③ Total treatment capacity of treatment facilities: 266,333 m^3/day
- Oxidation Ditch Process: 5 locations
- Sequential Batch Reactor: 2 locations

④Manhole Pump Station: 73 locations
⑤Pump Station: 3 locations
⑥Interceptor: 180,658 m
⑦Conversion Manhole: 545 locations
⑧Construction period ~2028
⑨Construction cost 22,604 MP (including land acquisition cost 2,652 MP)
⑩Effect Effluent discharge into Manila Bay with quality no greater than 50 mg/ℓ standard
⑪Sludge Treatment Process including sludge digesting process. Only installed in STP “P-11”

2) Description of Project Scope

The combined population of Parañaque and Las Piñas in 2008 accounted for 12 percent of the entire population under MWSI jurisdiction. As was stated in Section 4.1.6, the combined pollutant load from both cities in 2036 will be 62.7 t/day, and this load will flow into Manila Bay if the sewerage system is not constructed. Through constructing the sewerage system, it will be possible to greatly reduce the pollutant load entering Manila Bay to 5.6 t/day, thereby enabling a major water quality preservation effect.

The benefiting population in 2036 will be 1,479,630 (including part of the population of Pasay), and **Table 8-3-6** shows the design scale of the seven treatment districts. It is planned to treat the sewage from this area at seven sewage treatment plants. Each plant will install sewage treatment processes and sludge thickening tanks, however, the sludge treatment system will only be constructed at the P-11 plant so that this can conduct intensive treatment of the sludge gathered from the other facilities. Moreover, digestion tanks will be incorporated into the sludge treatment system so that methane gas can be captured, global warming can be addressed and the quantity of treated sludge can be reduced.

Due to the large scale of the construction, the work will be executed over phases as described in the next section. It is planned to divide the construction works into four phases by 2036.

Table 8-3-6 Project Scale

ID No		L-22	P-11	P-4	P-2	P-6	L-A	L-C
1.STP	Treatment Volume (m^3/d)	38,910	77,028	28,845	24,799	13,968	30,851	51,934
	Treatment System	OD	SBR	OD	OD	OD	SBR	OD
	Quantity	1	1	1	1	1	1	1
2. Pump Station	ID No	PS-6					PS-2	PS-4
	Pump Dischage (m^3/min)	16.6					19.1	16.6
	Quantity	1					1	1
3. Manhole Pump	Power(kw)	3.7～22	1.5～22	3.7～22	3.7～15	5.5	1.5～11	1.5～11
	Quantity	15	24	2	2	0	12	18
4. Force Main Pipe	Diameter(mm)	75～400	100～500	150～500	150～400	150	75～400	75～400
	Length (m)	3,490	8	280	110	0	4,720	5,110
5. Interceptor(Gravity	Diameter(mm)	150～1350	150～1350	150～900	150～900	150～700	150～700	150～1350
	Length (m)	21,780	48,810	24,460	12,940	5,170	21,600	32,180
6. Conversion	Size(700mm)	51	106	40	28	2	37	107
	Size(1000mm)	25	50	16	10	2	18	53

8.3.5 Project Implementation Plan

1) Construction Schedule

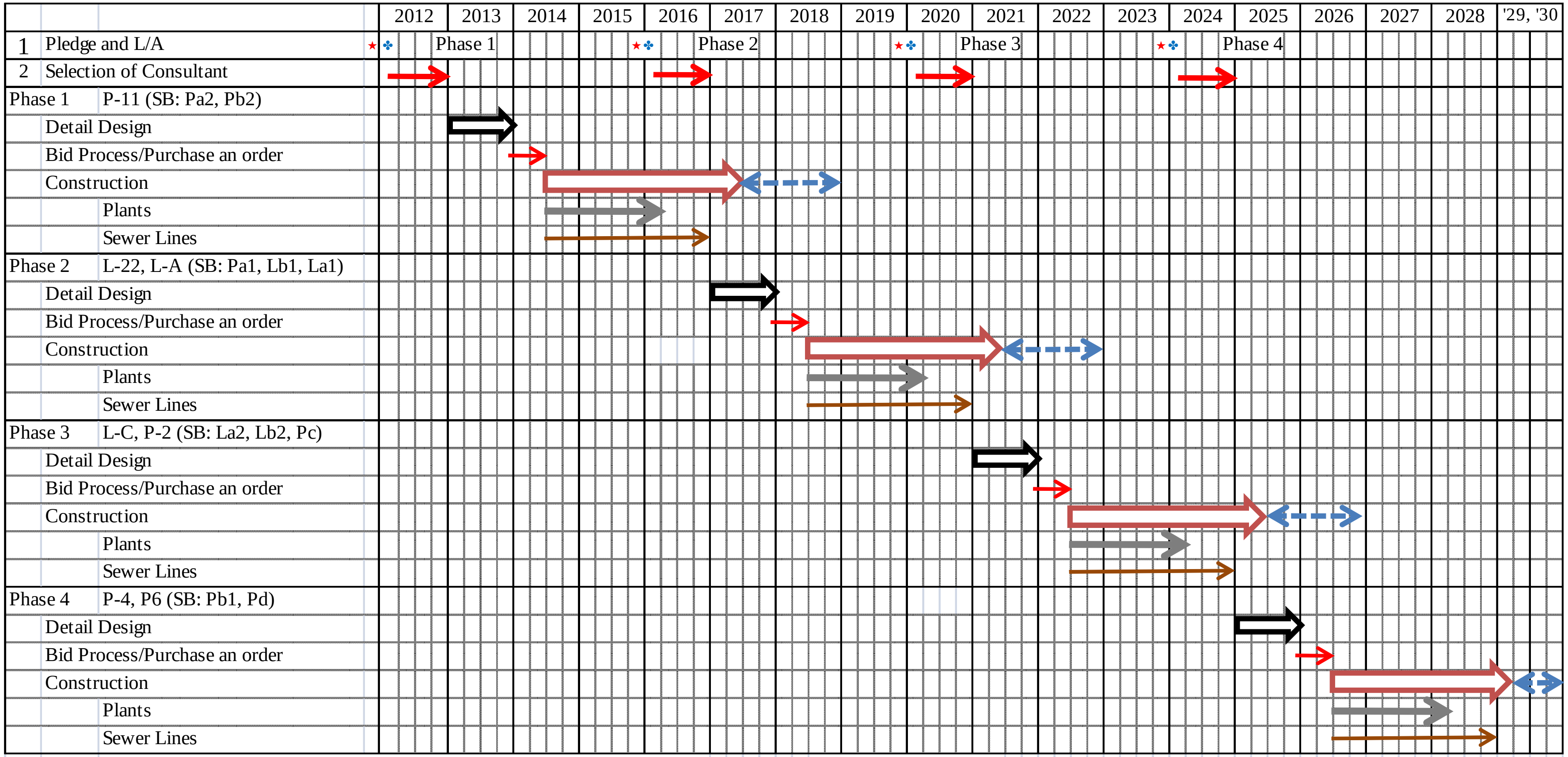
Due to the large size of the plan, construction will be divided into four phases. Regarding the order of construction, **Table 8-3-7** show the phasing plan that has been determined with a view to realizing an early project effect in relation to the investment and building treatment facilities first in upstream areas so that water quality in upstream creeks can be improved through a dilution effect, thereby providing a model effect for other districts. Incidentally, the plan of treatment facilities includes both sewage water treatment and sludge treatment facilities.

Table 8-3-7 Construction Phasing Plan

Construction Phase	Loan Agreement	Detail Design	Tender	Construction & Procurement*1)	Service Commence
Phase 1	2012 Mar.	Jan. -Dec. 2013	Jan.-Jun. 2014	Jul. '14 - Dec '16	Jan. 2017
Phase 2	2016 Mar.	Jan. -Dec. 2017	Jan.-Jun. 2018	Jul. '18 - Dec '20	Jan. 2021
Phase 3	2020 Mar.	Jan. -Dec. 2021	Jan.-Jun. 2022	Jul. '22 - Dec '24	Jan. 2025
Phase 4	2024 Mar.	Jan. -Dec. 2025	Jan.-Jun. 2026	Jul. '26 - Dec '28	Jan. 2029
Engagement of Consulting service contract:			Phase 1: Dec. 2012	Phase 2: Dec. 2016	
			Phase 3: Dec. 2020	Phase 4: Dec. 2024	

Note: *1) After completion of construction, another 6 months extension shall be deemed as construction period.

Figure 8-3-1Construction Implementation Plan



Notes:
1) ★ means Pledge in December, and ✤ Loan Agreement (L/A)in February.
2) Pledge will be made in December of last year before L/A is done.
3) Sewer lines Including construction of PSs, CMHs, MHPs, Interceptors
4) Red lines mean critical passes.
4) SB means Sub-basin.
5) ⇠⇢ Field operation for verification
6) Construction schedule is extended 6 months after completion of construction because of identificatin of plant running and operation verified.

Table 8-3-8 Project Cost and Scope

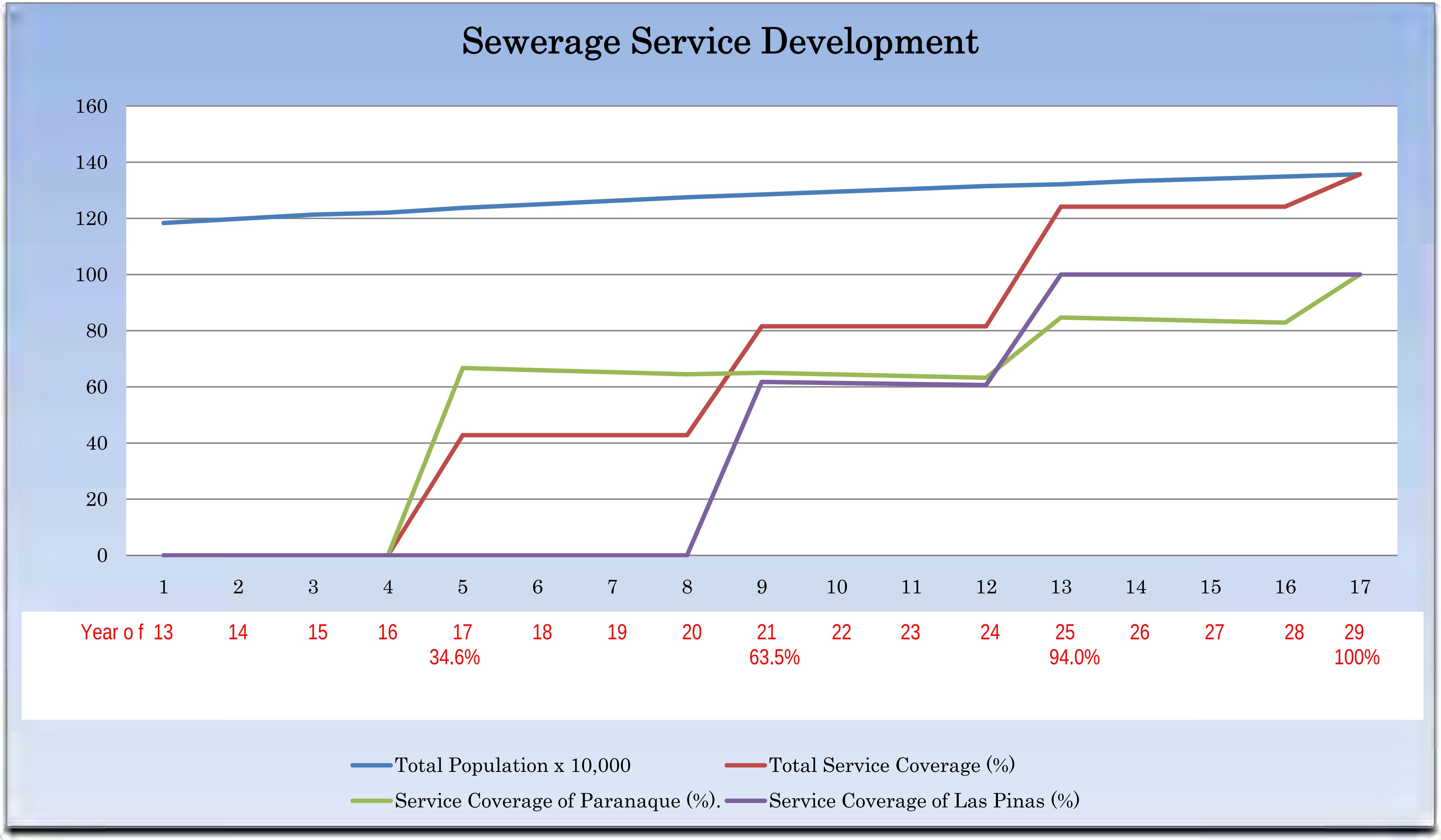
Construction		STP		Number of Sewer Collection Facilities				Construction Cost	Land Acquisition				Project Total Cost
Phase	Completion Year	Location	Capacity m^3/d	PS set	MHP pc	CMH pc	Interceptor km		STP		PS		
									ha	Cost	ha	Cost	
1	2016	P-11	77,028	0	24	156	48.8	6,172,318	7.620	76,200	-	-	6,248,518
2	2020	L-22	38,910	1	15	76	25.3	2,725,642	19.000	190,000	1.988	3,976	2,919,618
		L-A	30,851	1	12	55	26.3	2,597,307	3.200	162,500	0.054	756	2,760,563
3	2024	L-C	51,934	1	18	160	37.3	3,756,388	7.000	35,000	0.204	3,060	3,794,448
		P-2	24,799	0	2	38	13.1	1,660,092	4.200	1,260,000	-	-	2,920,092
4	2028	P-4	28,845	0	2	56	24.7	2,113,134	8.800	396,000	-	-	2,509,134
		P-6	13,968	0	0	4	5.2	927,142	13.200	528,000	-	-	1,455,142
Total			266,335	3	73	545	181	19,952,023	63	2,647,700	2.246	7,792	22,607,515

STP : Sewerage Treatment Plant Including Sewage Sludge Treatment Process)
PS : Pumping Station
MHP : Manhole Pump
CMH : Conversion Manhole

Notes: 1. The costs in the table 8-3-8 do not include engineering cost (consultant fee), price escalation and contingency.

2. Overall project budget breakdown is shown in Annex 8 together with each phase budget breakdown.

Figure 8-3-2 Sewerage Service Development



2) Stakeholders and Sewerage Service Charges

The stakeholders of this project are relative personnel or agencies to the project goals, objectives and outputs that are described in **Table 8-3-9** "Project Framework". However, main stakeholders of this project are the prospective residents covered by sewerage service in Parañaque and Las Piñas Cities. **Figure 8-3-3 and 8-3-4** show development number of sewerage service beneficiaries.

Table 8-3-10 shows how much additional charge is necessary to water tariff in order to recover the project capital cost and sustain the operation cost. According to the table, at the project final stage 0.036 pesos /l.month should be added to the current water tariff. **Table 8-3-11** shows indicative water tariff calculations based on the current Maynilad water tariff policy. The result shows that after completion of the project, about 1.9 times the current water tariff would be required to the service residents.

Table 8-3-9 (1/2) Project Framework

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
1. Goals			
To improve of life and health status urban residents in Paranaque and Las Piñas Cities.	Improved environmental conditions and reduced incidence of waterborne diseases.	Baseline survey on health, pollution, and coverage of sewerage and sanitation services.	
To promote regional economic development and reduce migration from the cities to the other districts	Increased investment and per-capita income and reduce net migration from the districts.	Local government statistics on investment and income in the project cities. Government statistics on population migration to/ from the project districts.	
2. Objective			
To improve sewerage and sanitation conditions in Paranaque and Las Piñas	Increased coverage and efficiency of urban sewerage and sanitation services. Reduces pollution of surface water. Rehabilitated and upgraded drainage, wastewater, sanitation, and sludge infrastructure in the target areas.	Baseline survey on pollution of surface water before and after Project. Project progress reports, loan review missions, completion reports and post-project evaluations.	Central and local governments adopt and implement the institutional and policy reforms necessary to facilitate sustainable management of urban services, including solid waste management and river/creek silt controls.
	Promote poverty families' domestic water supply and wastewater drainage facilities.		Sewerage and sanitation management fees increased to ensure that MWSI has enough resources for proper operation and maintenance of sewerage collection and treatment systems.
3. Output			
(a) Establish sewerage treatment and management systems for the cities	100% of completion of sewerage treatment plants and sewage collection sewer lines at each project phase completion year, as;	Physical inspections, project progress reports, loan review missions and post Project evaluations.	Land acquisition plan timely implemented. Available and timely release of loan fund. Timely recruitment of competent consultants.
	Phase 1: One STP, and 48.8 km sewer collection lines by year 2016	Ward recorded of services. MWSI customer and operation records.	MWSS/MWSI appoint qualified and experienced staff to the project implementation unit.
	Phase 2: Two STPs, and 51.6 km sewer collection lines by year 2020		
	Phase 3: Two STPs, and 50.4 km sewer collection lines by year 2024		Coordination and effective arrangement of the other sewerage and sanitation implementation programs under parallel construction running.
	Phase 4: Two STPs, and 29.9 km sewer collection lines by year 2028		

Table 8-3-9 (2/2) Project Framework

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
(b) Capacity building for improved autonomy. managerial, and technical capacity of MWSI	O & M plans, manuals and being used correctly and proper budgets allocated for O & M. Increased managerial and technical capacity of staff in MWSI. MWSS capabilities to coordinate and monitor MWSI operations. Water surcharge for sewerage service implemented to recover O & M costs of sewage and sewage sludge systems by 2036. Environmental charge on water supply by 2036 to recover capital cost investments in the sewerage and sanitation established.	MWSS/MWSI organizational chart and staff records. Job description and training plans. Training reports and tests of staff. Project progress reports, loan review missions and post-evaluations. Financial and management information reports, O & M documents and inspections. Annual budget. Customer complaint records. Tariff schedule increases and income collected. Billing statistics.	Project implementation cost-recovery tariff and budget allocations necessary for financial sustainability. Appropriate staff made available for training. Sufficient coordination among departments within MWSI and with other concerned agencies.
4. Inputs			
(a) Sewerage and sewage sludge treatment construction with sewer collection systems	Phase 1: 6,577 MP by 2016 Phase 2: 6,009 MP by 2020 Phase 3: 7,040 MP by 2024 Phase 4: 4,293 MP by 2028 Total 23,920 MP		
(b) Capacity buildings			Overseas Training as attached program: MWSS: 390 MP for 18 M/M MWSI: 1,160 M/M for 54 M/M

Figure 8-3-3 Sewerage Implementation in Parañaque and Las Piñas

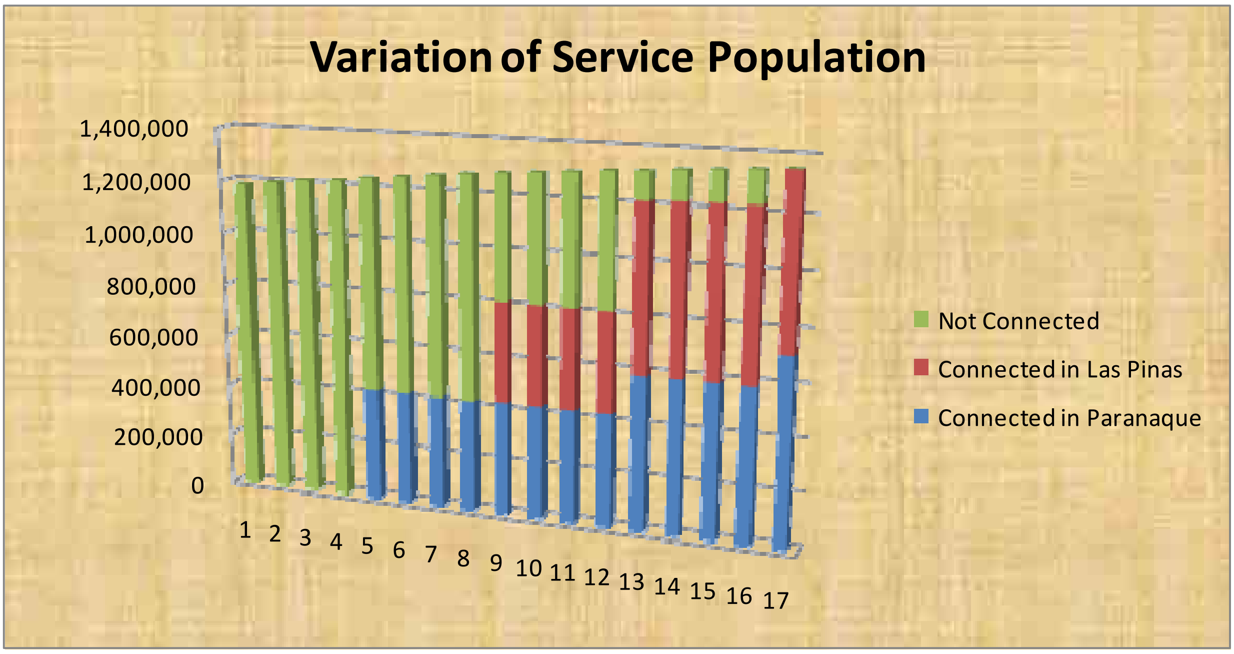


Table 8-3-10 Additional Sewerage Charge

Construction Phase	Year of Service Commencement	Service Population Total Population	Water Demand Projection L/pcp	(c)ML/month	(a) Operation (O & M) Cost/Yr Cumulative MP	(b) Construction Cost Cumulative MP	Additional Monthly Cost (a+b/40)/12/c Php/L.month	Environmental Charge of 20% P/L.month	Total Charge Additional for Sewerage P/L.month
Phase 1	2017	427,932	180	2,311	697	6,249	0.031	0.006	0.037
		1,237,607		6,683			0.011	0.002	0.013
Phase 2	2021	815,489	186	4,538	1,295	11,926	0.029	0.006	0.035
		1,284,930		7,151			0.019	0.004	0.022
Phase 3	2025	1,215,239	186	6,763	1,839	18,640	0.028	0.006	0.034
		1,321,618		7,355			0.026	0.005	0.031
Phase 4	2029	1,356,866*1	186	7,551	2,138	22,604	0.030	0.006	0.036
		1,356,866		7,551			0.030	0.006	0.036
		*1: Population defined only in Palañaque and Las Piñas.							

Table 8-3-11 Assumption of Sewerage Charge added to Water Tariff

Standard Family Water Expenses-1 ($30m^3$/M)			New Charge		Standard Family Water Expenses-2 ($10m^3$/M)			New Charge	
Charge per m^3	19.07		19.07		Charge per m^3	12.93		12.93	
Basic Charge	572.11		572.11		Basic Charge	129.31		129.31	
FCDA	0.54		0.54		FCDA	0.12		0.01	
Environmnetal Charge	91.45	16%	91.45	16%	Environmnetal Charge	20.67	16%	20.67	16%
Sewer Charge	114.31	20%	900.00	157%	Sewer Charge	25.84	20%	203.42	157%
MSC	1.50		1.50		MSC	1.50		0.34	
VAT	93.46	16%	93.46	16%	VAT	21.26	16%	21.12	16%
Total	873.37		1,678.13	1.92 times	Total	198.70		387.81	1.95 times

Figure 8-3-4 Service Population at Each Phase

Year	Copmmencement of sewerage Service				Max. Service Population		Paranaque			Las Pinas			Both Cities		
					Additional	Total	Total Pop	Service Pop	Coverage (%)	Total Pop	Service Pop	Coverage (%)	Total Pop	Service Pop	Coverage (%)
2013							609,285	0	0.0	574,468	0	0.0	1,183,753	0	0.0
2014							617,886	0	0.0	580,552	0	0.0	1,198,438	0	0.0
2015	P-11						626,609	0	0.0	586,701	0	0.0	1,213,309	0	0.0
2016	77,028						633,857	0	0.0	586,701	0	0.0	1,220,557	0	0.0
2017					427,932	427,932	641,189	427,932	66.7	596,419	0	0.0	1,237,607	427,932	34.6
2018							648,605	427,932	66.0	601,338	0	0.0	1,249,943	427,932	34.2
2019		L-22 + L-A					656,108	427,932	65.2	606,297	0	0.0	1,262,405	427,932	33.9
2020		69,761					663,697	427,932	64.5	611,298	0	0.0	1,274,995	427,932	33.6
2021					387,557	815,489	669,860	435,561	65.0	615,070	379,928	61.8	1,284,930	815,489	63.5
2022							676,081	435,561	64.4	618,866	379,928	61.4	1,294,946	815,489	63.0
2023			L-C+ P-2				682,359	435,561	63.8	622,685	379,928	61.0	1,305,044	815,489	62.5
2024			76,733				688,696	435,561	63.2	626,527	379,928	60.6	1,315,223	815,489	62.0
2025					426,291	1,241,780	695,091	588,712	84.7	626,527	626,527	100.0	1,321,618	1,215,239	92.0
2026							700,130	588,712	84.1	633,127	633,127	100.0	1,333,257	1,221,839	91.6
2027				P4 + P-6			705,205	588,712	83.5	635,873	635,873	100.0	1,341,078	1,224,585	91.3
2028				42,813			710,317	588,712	82.9	638,630	638,630	100.0	1,348,947	1,227,342	91.0
2029					237,850	1,479,630	715,466	715,466	100.0	641,399	641,399	100.0	1,356,866	1,356,866	100.0
2030							720,653	720,653	100.0	644,181	644,181	100.0	1,364,833	1,364,833	100.0
2031							724,263	724,263	100.0	645,662	645,662	100.0	1,369,924	1,369,924	100.0
2032							727,891	727,891	100.0	647,146	647,146	100.0	1,375,037	1,375,037	100.0
2033							731,537	731,537	100.0	648,634	648,634	100.0	1,380,171	1,380,171	100.0
2034							735,202	735,202	100.0	650,125	650,125	100.0	1,385,327	1,385,327	100.0
2035					Total Capacity		738,885	738,885	100.0	651,620	651,620	100.0	1,390,504	1,390,504	100.0
2036	77,028	69,761	76,733	42,813	266,355m^3/d		740,871	740,871	100.0	652,737	652,737	100.0	1,393,608	*1)1,479,630	100.0
												Note:	*1) Include 86,022 from Pasay City.		

8.3.6 Contract Package

Contract packages are divided into two categories, one for international bids and another for domestic bids. The contracts for sewage treatment facilities shall be made for each phase. Interceptors, manhole pumps and pumping stations shall be ordered to local bidders and contract packages shall basically be divided into each phasing schedule. However, pump stations works and interceptor with manhole pumps shall be divided into independent contract bid.

The Contract Package Plan will be divided into three parts, namely 1) treatment facilities, 2) manhole pumps and interceptors, and 3) pump stations. Since the Philippine side has little experience of treatment plants, the construction of treatment facilities will be open to international tender. Meanwhile, sewer construction and pumping stations shall be open to domestic tender because the Philippine side has ample experience in this area. The design and build method cannot be recommended because consistency in terms of technical, quality and lead-time cannot be guaranteed between different contractors. Since the manhole pumps, interceptors and pump stations can be divided into small works sections, they will be open to local tender. The sewers, pump facilities and treatment facilities are important facilities, and it will be necessary to conduct design work and works management in order to fully realize their capability.

Works procurement entails the seven sewage treatment plants (Pa2+Pb2, Pa1+Lb1, La1, Pc, La2+Lb2, Pb1, Pd,) and the interceptors for conveying sewage to the plants. The interceptors also include manhole pumps and pump stations.

Since the Philippine side has little experience treatment plants, these facilities shall be opened to international tender. Meanwhile, sewer construction shall be open to domestic tender because the Philippine side has ample experience in this area. **Table8-3-12** shows the project work procurement plan.

Table8-3-12 Work procurement plan

1	2	3	4	5	6	7	8	9
Phase	Contract (Component)	Estimated Cost M Pesos	Procurement Method	P-Q	Preference (yes/no)	Review by JICA (Prior/Post)	Expected Bid Opening Data	Contruct Rod
Phase1	STP （P-11）	4,982	ICB	No	No	Prior	Jul. 2014	1
	Collection System	1,191	LCB	No	No	Post	Jul. 2014	1
Phase2	STP (L-22）	2,129	ICB	No	No	Prior	Jul. 2018	1
	Collection System	597	LCB	No	No	Post	Jul. 2018	1
	STP (L-A）	1,996	ICB	No	No	Prior	Jul. 2018	1
	Collection System	601	LCB	No	No	Post	Jul. 2018	1
Phase3	STP (P-2）	1,357	ICB	No	No	Prior	Jul. 2022	1
	Collection System	303	LCB	No	No	Post	Jul. 2022	1
	STP (L-c）	2,853	ICB	No	No	Prior	Jul. 2022	1
	Collection System	903	LCB	No	No	Post	Jul. 2022	1
Phase4	STP (P-4）	1,576	ICB	No	No	Prior	Jul. 2026	1
	Collection System	537	LCB	No	No	Post	Jul. 2026	1
	STP (P-6）	766	ICB	No	No	Prior	Jul. 2026	1
	Collection System	161	LCB	No	No	Post	Jul. 2026	1

8.3.7 Organization of Project Implementation

1) Associated Agencies for Implementation of the Project

Mainland Water Service, Inc. (MWSI), the implementing agency, shall carry out project procurement activities through its Project Implementation Unit (PIU). Department of Program Management is responsible for the project implementation and department of sewerage and sanitation is responsible for the sewerage system operation, thus the PIU should compose of appropriate staffs from both departments. Project manager of PIU shall be chosen from these departments.

The sewerage treatment projects relate to various government agencies. The Department of Health (DOH) is the principal government organization responsible for planning, implementation and coordination of the policies and programs for public health protection and sanitation. The DENR is the primary government agency responsible for the promulgation of rules and regulations for the control of water, air, and land pollution in the Philippines. EMB is a line bureau of DENR and is mandated to formulate policies on environment and implement environmental laws.

The Department of Public Works and Highways (DPWH) is the government agency that is in-charge of infrastructure construction. Under the Clean Water Act (CWA), the DPWH is given the lead role with regards to the preparation of the national program on sewerage and septage management.

MWSS, attached agency to the DPWH, is responsible for domestic sewage collection, disposal, and treatment in Metro Manila and the surrounding municipalities, and the operations of the facilities of MWSS were turned over to MWSI and MWCI.

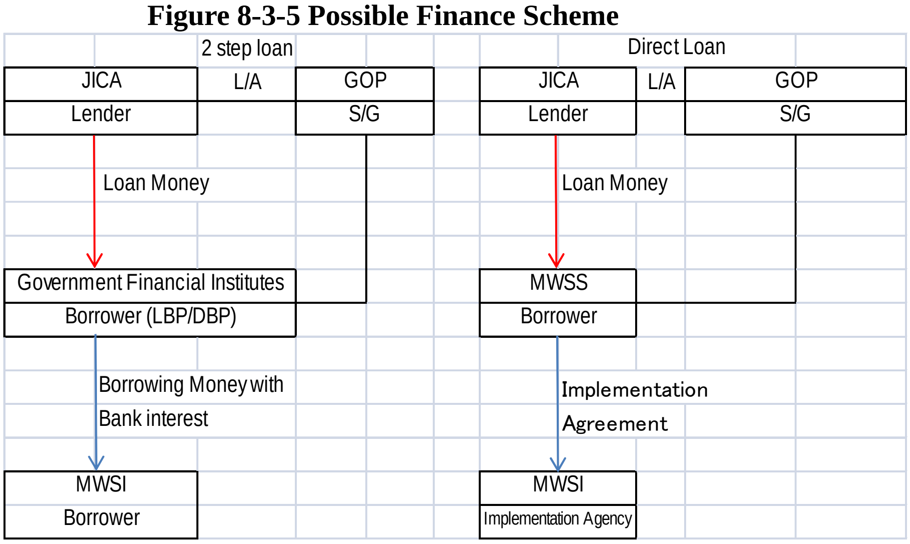
MMDA is responsible for management of solid waste and maintenance of rivers or creeks. LGUs are responsible for the provision of basic services, such as water supply systems, sewerage, and sanitation, either directly or through contracts with the private sector. They are also empowered to collect taxes and fees necessary for providing these services.

Under this proposed project, it is necessary for the departments to coordinate closely in order to maximize the impacts of the sewerage treatment development programs.

2) Project Implementation Structure

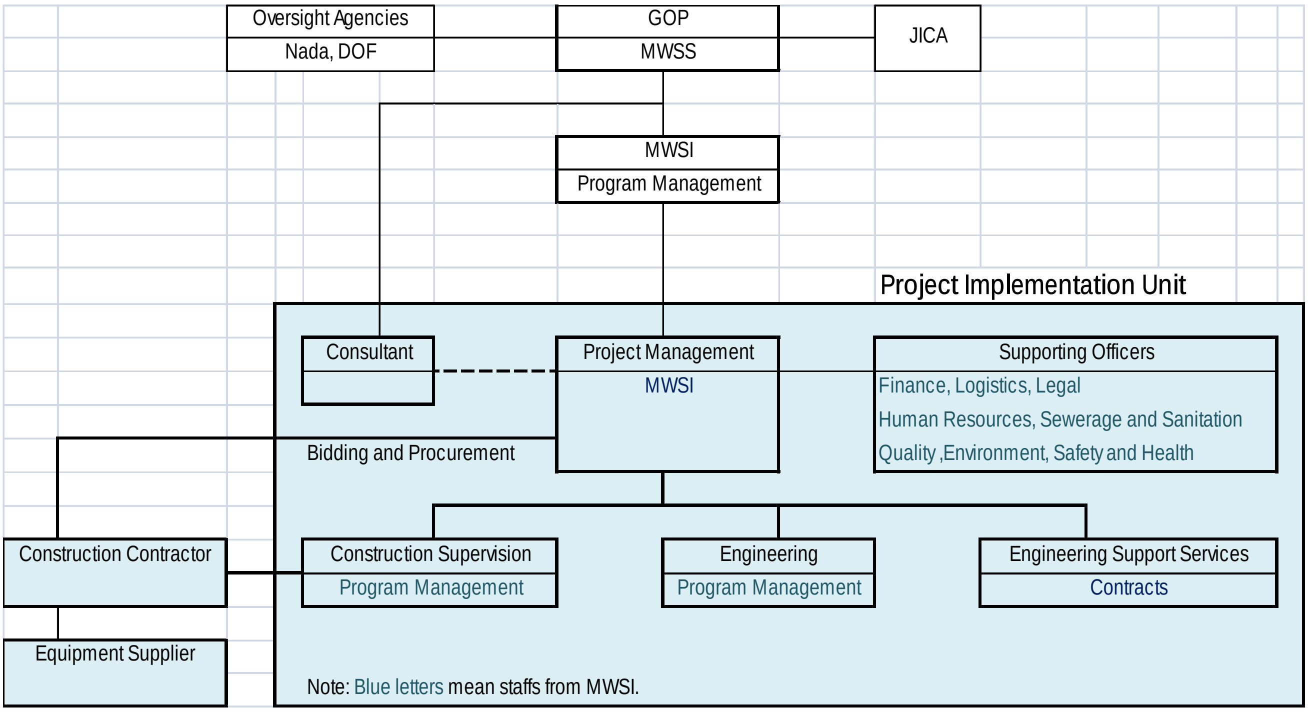
PIU organization will not be differed by project loaning structure. There would be two way to fund for the project (loan money), one is direct loan from JICA; another is two step loan from JICA through Government Financial Institutes (GFIs). The flow of the loan money is shown in **Figure 8-3-5**.

Figure 8-3-5 Possible Finance Scheme



In any case, the project implementation unit organization should be the same. **Figure 8-3-6** shows project implementation structure. Difference between the case of MWSS and GFIs as borrower just is in repayment responsibility to JICA (donor).

Figure 8-3-6 Project Implementation Structure



Relative agencies roles are shown hereunder.

Roles of Relative Agencies

LGUs	Assist in selection of site for treatment facilities, and information dissemination of information of the project area
	Review Project, Its alignment and project implementation schedule with other government project
	Ensure proper implementation of Project through resolution with correction in the Project area
	Ensure proper maintenance of drainage
DPWH	Ensure proper implementation of Project through resolution sold with correction in the PJ areas
	Ensure proper maintenance of drainage
	Review Project, Its alignment and project implementation schedule with other government project
DENR	Ensure that no untreated industrial waste enter drainage
	Assist speedy issuance environmental permits of the project
	Review Project, Its alignment and project implementation schedule with other government project
MMDA	Ensure proper implementation of Project through resolution with correction in the PJ areas
	Ensure proper maintenance of drainage
DOH	Monitoring implementation of Project based on sanitation code
	Assist issuance for all sanitation permits of the project

Roles of Project Implementation Agencies

GOP	Approve Project, provide sovereign guarantee, and secure loan from JICA
MWSS	Monitors Project implementation of MWSI, and submit report to JICA
	Review project proposal of MWSI and recommends to GOP for Government borrowing to JICA
MWSI	Preparing and submit Project proposal to MWSS,
	Implementing Project
	Submit reports of implementation to MWSS
	Provides funds for the loan payment

Table 8-3-13(1) Operation Indicator

Regarding project target area

Category	Name	Policy and method of establishing the indicator※2	Base Line	Target	Purpose	Remarks
Basic	Population Treated(Persons)	Population treated=(population connected to sewage network) Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):427,932 ph2(2023):387,567 ph3(2027):399,740 ph4(2031):141,627	To assess if the sewage water operation is properly conducted	Values should be constantly improving when the project is effective. When the population connected to sewage network is unknown, adopt similar indicators(population served with water supply, population in the area sewage system is installed, etc.)
Basic	Amount of Wastewater Treated (m^3/Day)	As shown by the name of the indicator Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):77,028m^3/d ph2(2023):69,761m^3/d ph3(2027):76,731m^3/d ph4(2031):42,813m^3/d	To assess if the sewage water operation is properly conducted	Values should be constantly improving when the project is effective. (Indicator covers the treatment of industrial waste water as well)
	Rate of Facility Utilization(%)	Rate of Utilization=(daily average amount of treated wastewater)/(capacity of the facility) Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To assess if the network improvement is properly conducted	This corresponds to rate of facility operation. It is desirable to indicate 40% or over three years after stating operation.
Basic	BOD Concentration-influent, effluent, reduction rate (mg/ℓ; assessed monthly)	As shown by the name of the indicator Monthly data (monthly average of data obtained regularly)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):50mg/ℓ ph2(2023):50mg/ℓ ph3(2027):50mg/ℓ ph4(2031):50mg/ℓ	To assess if the treatment plant is properly operated	When the treated wastewater is discharged into closed waters (lakes, inland sea, etc.), substitute the indicator by COD ※3. Reduction rate: 70－85％
Auxiliary	Covered Ratio of Sewer Main(%)	Covered ratio=(length of sewage pipes covered)/(planned total length) Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To assess if the network improvement is properly conducted	Sewer main is referred to as sewage pipe that is directly connected to a treatment plant or pumping station.
Auxiliary	Suspended Solid(TSS) Concentration※3 influent, effluent reduction rate(mg/ℓ; assessed monthly)	As shown by the name of the indicator Monthly data (monthly average of data obtained regularly)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):70mg/ℓ ph2(2023):70mg/ℓ ph3(2027):70mg/ℓ ph4(2031):70mg/ℓ	To assess if the treatment plant is properly operated	
Auxiliary	Form of Sludge Disposal (each form DS※3-T/Year)	Amount of sludge disposal by form of disposal※4 Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):2,482t ph2(2023):2,227t ph3(2027):2,446t ph4(2031):1,387t	To assess effect of environment burden reduction and resource recovery.	promotion of recycling should be strongly demanded as far as possible.
Auxiliary	Rate of Service Charge Recovery(%)	Rate of service charge recovery=(recovered service charge)/(service charge claimed) Yearly data (annual average worked out from monthly data)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph3(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To assess if guidance and dissemination to local residents are properly carried out.	Management indicator; it is desirable to improve the rate closer to 100%

Note) Ph1:Phase1

Table 8-3-13(2) Operation Indicator

Regarding project target area						
Category	Name	Policy and method of establishing the indicator※2	Base Line	Target	Purpose	Remarks
Auxiliary	Sludge generation rate Generated amount of sludge (m3/d) Sludge concentration (%)	As indicated in the name of the indicator Monthly indicator (monthly average of periodically acquired data) Sludge generation rate = Generated amount of sludge Ds -t/d/SS amount of reduction Ds-t/d	ph1(2011):0	ph1(2019):1,073m3/d	Assess whether the sludge treatment facilities are appropriately managed or not.	Operation that ensures around 75% of the daily average SS reduction amount is desirable.
			ph2(2011):0	ph2(2023):971m3/d		
			ph3(2011):0	ph3(2027):1,069m3/d		
			ph4(2011):0	ph4(2031):596m3/d		
Auxiliary	Thickened sludge quantity (m^3/d) Sludge concentration (%) Organic content (%)	As indicated in the name of the indicator Monthly data (monthly average of periodically acquired data)	ph1(2011):0	ph1(2019):425m3/d	Assess whether the sludge thickening equipment is appropriately managed or not.	In the case of gravity thickening, sludge concentration is around 1~3%.
			ph2(2011):0	ph2(2023):385m3/d		
			ph3(2011):0	ph3(2027):424m3/d		
			ph4(2011):0	ph4(2031):236m3/d		
	Rate of Facility Utilization(%)	Rate of Utilization=(daily average amount of treated wastewater)/(capacity of the facility) Yearly data	ph1(2011):0	ph1(2019):100	To assess if the network improvement is properly conducted	This corresponds to rate of facility operation. It is desirable to indicate 40% or over three years after stating operation.
			ph2(2011):0	ph2(2023):100		
			ph3(2011):0	ph3(2027):100		
			ph4(2011):0	ph4(2031):100		
Auxiliary	Sludge digestion rate (digested sludge amount m3/d, sludge concentration %)	As indicated in the name of the indicator Digestion rate = Digested sludge Ds/Thickened sludge Ds	ph1(2011):0	ph1(2019):425m3/d	Assess whether the anaerobic digestion equipment is appropriately managed or not.	As far as possible, it is desirable to achieve a digestion rate of no more than 60%.
			ph2(2011):0	ph2(2023):385m3/d		
			ph3(2011):0	ph3(2027):424m3/d		
			ph4(2011):0	ph4(2031):236m3/d		
Auxiliary	Digestion gas generation rate Generated amount of digestion gas m^3/d	As indicated in the name of the indicator Generation rate = Generated amount of digestion gas m3/d//organize content of thickened sludge kg/d	ph1(2011):0	ph1(2019):9,681m3/d	Assess whether the anaerobic digestion equipment is appropriately managed or not.	As far as possible, it is desirable to achieve a generation rate of 0.6 m3 per kilogram of organic matter put into the digestion tank
			ph2(2011):0	ph2(2023):8,770m3/d		
			ph3(2011):0	ph3(2027):9,043m3/d		
			ph4(2011):0	ph4(2031):3,205m3/d		
Auxiliary	Form of effective use of digestion gas (methane gas) (10^3m3/year)	Stated usage by form of use Monthly data	ph1(2011):0	ph1(2019):3,534m3/y	Assess the greenhouse gas reduction effect.	This should be recycled as much as possible.
			ph2(2011):0	ph2(2023):3,201m3/y		
			ph3(2011):0	ph3(2027):3,301m3/y		
			ph4(2011):0	ph4(2031):1,170m3/y		

Table 8-3-14 (1) Effect Indicator

Effect Indicator						
Regarding Project target area						
Category	Name	Policy and method of establishing the indicator[※2]	Base Line	Target	Purpose	Remarks
Basic	Percentage of population Served(%)	Percentage of Population Served=(Population that is actually served with treatment)/(target population of treatment service) Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To assess if the sewage water operation is properly conducted.	Indicator for the whole project Plan.
Basic	Improvement of water Quality (BOD/COD)	As shown by the name of the indicator Monthly data(monthly average of data obtained regularly)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):7(10) ph2(2023):7(10) ph3(2027):7(10) ph4(2031):7(10)	To assess if sewage project is effective.	When the treated wastewater is discharged into closed waters (lakes, inland sea, etc.), substitute the indicator by COD[※3].
Basic	BOD Concentration (when discharged) (mg/ℓ)	As shown by the name of the indicator Monthly data(monthly average of data obtained regularly)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):50 ph2(2023):50 ph3(2027):50 ph4(2031):50	To assess if sewage project is effective.	
Auxiliary	Percentage of population Connected(%)	Percentage of population Connected=(population connected to sewage network)/(target population of treatment service) Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To assess if the network improvement is properly conducted.	Indicator for the whole project Plan.
Auxiliary	Ratio of Cost Recovery(%)[※5]	Ratio of cost recovery=(Amount of service charge collected)/(cost of treatment service) Yearly data (annual average worked out from monthly data)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To assess if sewage project is properly managed	Management indicator: it should cover at least maintenance and operation costs.
Auxiliary	Reducing Ratio of Sludge Disposal(%)[※6]	(Volume recycled)/ (volume of sludge) Yearly data (annual average worked out from monthly data)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To assess if sewage project is properly managed	
Regarding whole administrative district						
Auxiliary	Percentage of population Served(%)[※7]	Percentage of Population Served=(Population that is actually served with treatment)/(population in the administrative district) Yearly data	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To confirm the degree of contribution of the project to the whole administrative district (residents)	Not reaching the target dose not always lead to low evaluation.

Table 8-3-14 (2) Effect Indicator

Table 8-3-14 (2) Effect Indicator

Auxiliary	Percentage of wastewater Treatment (%)	Percentage of wastewater Treatment=(volume of wastewater treatment)/(total volume of wastewater)	ph1(2011):0 ph2(2011):0 ph3(2011):0 ph4(2011):0	ph1(2019):100 ph2(2023):100 ph3(2027):100 ph4(2031):100	To confirm the degree of contribution of the project to the whole administrative district (residents and industry)	Not reaching the target dose not always lead to low evaluation.
	Benefit at two years after completion of each phase (1,000Php)	2019	2023	2027	2031	Total Benefits
Auxiliary	Avoided Cost on Medical Expence due to Water-Related Disease	5,135	4,651	4,797	1,700	16,283
	Savings due to Reduction in Morbidity	2,640,804	2,391,709	2,466,829	873,992	8,373,334
	Savings due to Reduction in Morbtality	316,897	287,005	296,019	104,879	1,004,800
	Total Benefits	2,962,836	2,683,365	2,767,645	980,571	9,394,417
	Improvement in water quality as a result of conducting sewage treatment	The Phase 1 sewage treatment will lead to improvement of water quality in San Dionisio River (a tributary of Parañaque River) and Kay Boboy Creek. In numerical terms, treatment will lead to improvement in river water quality from 17mg/ℓ to 4mg/ℓ, thereby achieving the DNR standard of 7mg/ℓ. In Phase 2, water quality will be improved in Villanueva Creek, also a tributary of Parañaque River, and the improvement effect will be the same as in Phase 1. Moreover, in Zapote River, treatment will lead to improvement in river water quality from 20mg/ℓ to 5mg/ℓ, thereby achieving the DNR standard. In Phase 3, water quality will be improved in Balot River, a tributary of Las Piñs River, with river water quality improving from 13mg/ℓ to 3mg/ℓ. Moreover, in Ibayo Creek, also a tributary of Parañaque River, treatment will improve the river water quality from 19mg/ℓ to 5mg/ℓ, thereby achieving the DNR standard. In Phase 4, water quality will be improved in Don Galo Creek, another tributary of Parañaque River, with river water quality improving from 19mg/ℓ to 5mg/ℓ. Therefore, the sewage treatment that will be implemented in Phases 1~4 will make a major contribution to water quality not only in rivers but also Manila Bay.				

Notes:

※1 Basic concept of operation indicators: indicate how well the operation of a sewage project is carried out in order to have the above mentioned effects
Basic concept of effect indicators: indicate how comfortable the daily life of community people has become(percentage of population served) and how well the water environment is conserved (water quality improvement)

※2 "Yearly data" is referred to as the end of the financial year, and "monthly data" as the values at the end of the month, and "data obtained regularly" as values obtained several times/week or daily.

※3 Densities of Biochemical Oxygen Demand(BOD), Chemical Oxygen Demand(COD), and Suspended Solids(SS) indicate the degree of organic contamination. Dried Sludge(DS) indicates the
In closed waters such as bays or lakes, the value of BOD is lower than the actual sludge volume. Accordingly it is desirable to indicate it by COD.
In a case in which the treated wastewater is discharged into a general sea area, it is desirable to indicate the degree of water quality improvement by the number of coli-aerogenes group or COD measured at the adjacent seashore.

※4 Forms of final disposal after sludge treatment at a treatment Plant include landfill, recycled as construction material, recycled as compost, etc.

※5 Basic cost includes operation and management cost of the treatment plants and sewage network. It should be decided through discussion with the executing agency if undistributed profits are to be included in preparation for the future. Even if self-support accounting is not attained, at least maintenance and operation cost should be paid by the service charge recovered.

※6 Generally, sludge is disposed in landfill at a cost. Promoting recycling of sludge in green or farm land will reduce the cost.

※7 As the most popular indicator in and out of Japan is percentage of population served at the autonomous community level, this indicator is established.

c) Recruiting Consultants to assist PIU

Since MWSI has not enough experience of the large scale sewage treatment plants like this project, and also has insufficient experience of design and construction of the plants together with the conversion manholes, interceptors incorporated into combined sewer collection systems. Therefore competent international consultant firm(s) should be recruited to join the PIU. Consultant services should cover both of project detail designs and construction supervises. Total numbers of consultant inputs for this work is estimated that international expert: 164 person-months, local engineer: 210 person-months and total cost is 4,995,000 us dollars. The consultant input schedule, cost and TORs are shown in Annex 7.

2) Indicators of Project Operation Effect

The operation indicators used for evaluating the Project are geared to grasping the state of facilities utilization, realization of functions and operation and maintenance, and such indicators shall be set to ensure that the implementing agency specifies the regular implementation of monitoring and appropriately conducts operation and maintenance. **Table 8-3-13(1),(2)** shows the operation indicators.

Effect indicators are set in order to clarify planned effects and measure degree of achievement of the Project purpose through quantitatively setting and grasping the attainment of effect items. **Table 8-3-14 (1),(2)**shows the effect indicators.

Table 8-3-15 Performance Indicators

Indicator		Base Line	Target (Year)				
		2012	2017	2021	2025	2029	2036
Service Population covered by New Sewerage Treatment System *1) (x 1,000)	Paranaque	0	428	436	589	715	741
	Las Pinas	0	0	380	627	641	653
	Total	0	428	816	1,216	1,356	1,349
Amount of Swage Water Treated (m3/d) *2)		0	77,028	146,789	223,522	266,355	266,355
BOD_5 concentration discharged into receiving water body including each phase construction area after completion of project construction		200mg /l and more	50mg/l or less	50mg/l or less	50mg/l or less	50mg/l or less	50mg/l or less

Notes *1). The sewerage system applies the combined sewer, thus house connection is not required.

*2). Refer Figure 8-3-4 Service Population at Each Phase.

8.4 Conceptual Designs

8.4.1 Technical Specifications

Table 8-4-1 shows the works items and works quantities for the seven planned treatment districts.

1) Conversion Manholes (CM)

Two types of conversion manholes, i.e. the type with inlet sewer diameter of ϕ 700 mm or less and the type with inlet diameter of ϕ 1,000 mm or more, will be installed at 545 locations around the outfalls of sewers that drain sanitary sewage into creeks.

2) Manhole Pump (MP)

Manhole pumps, which are simple structures comprising pumps installed in manholes with the aim of conveying the sanitary sewage separated in the conversion manholes to interceptors, are planned in 73 locations with pumping capacity ranging between 1.5~22 kw.

3) Force Main Pipe

Force main pipes, which are intended to convey sanitary sewage pumped by manhole pumps and pump stations to interceptors, are planned over 21,270 m with diameter ranging between ϕ 75 mm~600 mm.

4) Interceptor (gravity)

The sanitary sewage that is separated by the conversion manholes will be collected in the interceptors comprising 166,940 m of sewers with diameter of ϕ 150 mm~ ϕ 1000 mm for conveying the sewage to the treatment facilities at the end of the lines.

5) Pump Station (PS)

Since the buried depth of sewers along the interceptors becomes deep in places, pump stations will be constructed in order to reduce this depth. Pump stations with pumping capacity of 4.8 m^3/min~5.6 m^3/min will be constructed in three locations.

6) Sewage Treatment Plant (7STPs)

Sewage treatment plants are planned in seven locations, five of which will adopt the oxidation ditch process and two the sequencing batch reactor process.

Table 8-4-1 Works Items in the Seven Treatment Districts

Name		Pa1+Lb1	Pa2+Pb2	Pb1	Pc	Pd+Pe	La1	La2+Lb2
ID No		L-22	P-11	P-4	P-2	P-6	L-A	L-C
STP	Influent Wastewater（m^3/d）	38,910	77,028	28,845	24,799	13,968	30,851	51,934
	Treatment Process	OD	SBR	OD	OD	OD	SBR	OD
	Infulent BOD (mg/ℓ)	200	200	200	200	200	200	200
	Infulent SS (mg/ℓ)	200	200	200	200	200	200	200
	Outflow BOD (mg/ℓ)	50	50	50	50	50	50	50
	Outflow TSS (mg/ℓ)	70	70	70	70	70	70	70
PS	ID No	PS-6					PS-2	PS-4
	φ200×5.5m^3/m×15kw×4Unit(Place)	1						
	φ200×4.8m^3/m×15kw×5Unit(Place)						1	
	φ200×5.6m^3/m×15kw×4Unit(Place)							1
MP	1.5kw×2Unit (Place)	2					1	1
	2.2kw×2Unit (Place)						1	2
	3.7kw×2Unit (Place)	6	6				2	6
	5.5kw×2Unit (Place)	4	10		1		2	5
	7.5kw×2Unit (Place)	1	4	1			4	2
	11kw×2Unit (Place)	2	2				1	2
	15kw×2Unit (Place)		2	1	1			
	22kw×2Unit (Place)						1	
Force Main Pipe	75mm (m)	1,320					810	910
	100mm (m)		440				840	150
	150mm (m)	630	2,820				300	1,700
	200mm (m)	500	1,700				250	900
	250mm (m)		1,180	210			450	100
	300mm (m)	150	210		50		190	1,350
	350mm (m)	590	990					
	400mm (m)	150	220	70	60		430	
	450mm (m)							
	500mm (m)	150						
	600mm (m)						800	
Interceptor(Gravity Main)	150mm (m)	3,280	9,480	5,860	2,120	1,010	6,590	7,030
	200mm (m)	3,890	9,600	3,070	1,790	250	1,210	2,850
	250mm (m)	1,560	4,570	3,870	1,470	380	3,010	4,840
	300mm (m)	3,180	7,010	1,850	930		1,070	2,750
	350mm (m)	1,020	2,420	910	300			1,450
	400mm (m)	580	2,570	310	1,300		1,500	2,050
	450mm (m)	2,160	1,330		1,200		1,390	1,800
	500mm (m)	740	2,730	3,950	870	100	100	2,160
	600mm (m)	1,140	2,760	1,400	1,540		3,030	1,610
	700mm (m)	2,820	3,160	1,520	1,420	3,430	3,700	1,610
	800mm (m)	1,410		1,720				1,350
	900mm (m)		1,420					680
	1000mm (m)		1,340					1,250
	1100mm (m)							750
	1350mm (m)							
CM	700mm (Place)	51	106	40	28	2	37	107
	1000mm (Place)	25	50	16	10	2	18	53

注）1. STP:Treatment Plant、PS：Pump Station 、MP：Manhole Pump 、CM：Conversion Manhole

8.4.2 Project Design Drawings

Conceptual drawings of the facilities planned in the project are indicated according to the sewage flow in the order of: Conversion manhole (**Figure 3-3-1(1) and 3-3-1(2)** attached as appendix) , Manhole pump (**Figure 3-3-2** attached as appendix), Pump station (**Figure 3-3-3** attached as appendix), and Treatment plant (**Figure 3-4-1(1)** through **3-4-1(7)** attached as appendix).

8.4.3 Least Cost Study of Project Facility Construction

The following policies will be adopted in order to reduce the construction cost of sewerage facilities in the project.

● Installation height of treatment facilities

Treatment facilities will be installed between 1.5 m higher in order to reduce the costs of civil engineering works and earth retaining works. Since the planned locations of treatment facilities are in areas that were inundated in the past (according to the interview survey of flood level), it will be necessary to elevate facilities above this level.

● Prevention of groundwater infiltration

Groundwater infiltration of 20 ℓ/day/cap is expected during fine weather, however, infiltration will be prevented through improving the used sewer joints and installation methods.

● Primarily the OD process will be adopted in order to reduce construction and operating costs, and the SBR method will be adopted in places where the OD process cannot be applied.

●In order to reduce the construction cost and maintenance cost for sludge facilities, they will be consolidated into one location.

●Monitoring and control will be conducted by monitors in order to reduce the size of the monitoring building.

9. SUB PILOT PROJECT ENHANCING THE MAIN PROJECT ACTIVITIES

In the implementation of the sewerage projects in Parañaque and Las Piñas Cities, several supporting programs related to the sewerage systems considered useful to promote and enhance the sewerage and sanitation development are discussed. The program is focused on river cleaning and the promotion of sewerage system development to be implemented parallel with the proposed main project activities.

In order to the implementation programs of sewerage systems in Parañaque and Las Piñas Cities, several supporting programs related to the sewerage systems would be useful to promote and enhance the sewerage and sanitation development.

9.1 Supporting Program for Hygienic Improvement of Poverty Families

The combined sewerage system would be applied in the Project Target Areas, Parañaque and Las Piñas City.

The features of combined sewerage system area as follows;

a) Conversion manholes will be installed near the outfalls. Basically one outfall shall be connected to one conversion manhole, thus once the conversion manhole is connected to respective outfall, the areas where wastewater discharging to the drainage line is generated, are automatically connected to the sewerage treatment systems,
b) Thus, any connection work to connect house holds' drain pipe to the sewer lines is not required,
c) The residents included the drainage line will receive sewerage services irrelevantly to the residents' will,
d) The service charge shall be levied on the all residents in the area,
e) The service charge payment exception could not be applied to any individual household,
f) Unhygienic conditions of households without or insufficient sanitary facilities could not be improved after the sewerage system completed, and
g) It is difficult to charge the sewerage tariff to the households without water supply connection.

Taking consideration items f) and g) in the above features, provision shall be made for addressing such poverty families.

The measures addressing such poverty families would be prepared as follows;

1) Establishing Revolving Fund for Promoting Water supply and Sanitary Facility Installation

   Revolving fund, which would preferably be prepared by LGUs and MWSI, should better be established to encourage the households to install water supply and sanitary facilities.
   The predicted cost for the promotion would be as follows (per one family);

Water supply facility (Water pipe and tap)	P4,000
Water Closet (supply and install)	P6,800
φ150 PVC with Earth Work (10m)	P13,000
Total	p23,800

If the revolving fund is 250million pesos, about 400,000 people (40,000 families, assuming 10 persons per one family) could got the benefit the first 4 years, that means 32% of service population under the conditions described hereunder

Revolving Fund; 250MPhp
Repayment Period: 5 years
Payment Method: Monthly Installation (397 peso/month.family)
Interest: None
Revolved Fund relending Timing: every incipient year
Final Lending: The fourth year.

9.2 River Cleaning Activity Plan

The sewerage system establishment is the most effective way to clean up the rivers (river water). However, the residents' behavior to throw garbage in to the rivers, creeks or in public spaces is essential bother to hamper environmental improvement activities. **Picture 9-1** and **Picture 9-2** shows the current conditions of the rivers in the project areas. The solid wastes in the waterways are also one of the problems to secure good performances of the sewerage treatment systems. The environmental improvement of waterways also requires reducing the garbage dumping into the rivers and public spaces in parallel with sewerage treatment system development. The garbage left on the roads eventually are flown out by rain water into the street drainages and discharged into rivers through outfalls.

The rivers transporting bio-solids also accumulate silts on the riverbed. The silts should be dredged up periodically to keep smooth water stream and clean water. These problems would be expected to be improved through the following activities.

9.2.1 Solid Waste Management

1) Responsible Agencies (including river dredging)
Solid waste management is responsible for MMDA and LGUs
The duties of each agency are as follows;

(1) MMDA
- Rivers, esteros, and creek management
- Street drainage
- Cleaning of the city streets
- Dredging rivers/creeks and collecting the garbage

(2) LGUs, i.e. city governments of Parañaque and Las Piñas
- City garbage collection
- Transport of collected garbage to dump sites from city
- Management of the dump sites

2) Frequency of the Activities

- Street drainage - depends on budget
- Cleaning of the city streets - daily
- Dredging rivers/creeks & collecting the garbage - yearly, depends on budget
- City garbage collection - daily
- Transport of collected garbage to dump sites - daily

3) General Action Plan of Parañaque and Las Piñas

(1) Parañaque City (Information from Solid Waste and Environmental Sanitation Division)

a) Actual Schedule of Garbage Collection

- Collection of garbage along main roads is done every day (domestic waste).
- A garbage truck was provided for every barangay by the City Mayor. Scheduling of garbage collection is assigned for each barangay. The task of the City Environmental Division is only for monitoring.
- Garbage collected each day is transported to a *Transfer Station* located in Barangy. San Dionisio and then transferred to Montalban Dumpsite.

b) The basic parameters of Garbage Collection Plan

City Planning and Development Coordinator's Office studied the basic parameters as West Collection 2010. The parameters are as follows.

(a) Population

- Projected Population 2010 603,862 (based on 2007 NSO Census)
- Estimated Residential Waste 362.32 Tons
- Estimated Commercial/Industrial Waste 63.07 Tons
- Estimated Waste reduction due to Segregation 51.05 Tons (12% reduction)
- Estimated Volume of waste to be collected and disposed 374.34 Tons

c) Approximate Distance from Dispatch Area to Different Barangay

Barangay	Distance (Km)	Barangay	Distance (Km)
Baclaran	4.6	San Antonio	8.4
Tambo	3.2	BF Homes	7.1
Vitalez	4.1	Marcelo Green	9.07
Don Galo	2.2	Don Bosco	6.7
Sto Nino	2.0	San Martin de Porres	10.7
La Huerta	1.4	Sun Valley	8.3
San Dioisio	0.4	Moonwalk	2.9
San Isidro	3.2	Merville	5.5

Total Distance = 79.77 Km
Average Distance = 4.98 Km

Ave. Dist. Back & Forth = 9.97 Km

(a)Average Distance in Route Cell Collection 4.0 Km

(b)Approximate Distance to Dumpsite and Back 90 Km (45 x 2)

(c)Total Distance To be traveled per Trip 103.97 Km (9.97 + 4.0 + 90)

d) Volume of Garbage accumulated for the year 2010.

Garbage collected by the city in 2010 is shown in **Table 9-1** Garbage collected covers around 65% of Total garbage generated in the city. The others might be left in the city or in the rivers.

Table 9-1 Waste Collected for Year 2010 in Parañaque

Barangay	Population	Garbage Collected		No. of Trucks
		Kg	Ton	Required
Baclaran	28,535.00	1,712.00	17.1210	5.3490
Tambo	27,675.00	16,605.00	16.6050	5.2015
Don Galo	9,933.00	5,959.80	5.9598	1.8650
La Huerta	7,960.00	4,776.00	4.7760	1.6385
Sto. Niño	30,564.00	18,338.40	18.3384	5.5080
Vitalez	4,238.00	2,542.80	2.5428	0.8275
San Dionisio	66,642.00	39,985.20	39.9852	12.1775
San Isidro	65,893.00	39,535.80	39.5358	12.2350
San Antonio	69,781.00	36,468.60	36.4686	11.2965
BF	87,612.00	52,567.20	52.5672	15.8695
Sun Valley	38,668.00	23,200.80	23.2008	7.2095
Marcelo Green	30,656.00	18,393.60	18.3936	5.8030
Don Bosco	46,184.00	27,710.40	27.7104	8.3985
Merville	18,672.00	11,203.20	11.2032	3.7230
San Martin	25,656.00	15,393.60	15.3936	4.7870
Moonwalk	54,193.00	32,515.80	32.5158	10.0660
TOTAL	612,862.00	346,908.20	362.3172	111.9550

(2) Las Piñas City (Information from Environmental Sanitation Center)

a) Actual Schedule of Garbage Collection

- Collection of garbage is done every day from 7am until afternoon. They have been serving a total of 268 Subdivisions and Villages every day.
- Garbage collected each day is transported to a Transfer Station located at Pulang Lupa Uno and then transferred to San Pedro Laguna landfill.
- Please refer to the attached reference for the volume of garbage accumulated per month for year 2010.

b) Volume of Garbage accumulated for the year 2010

Garbage collected by the city in 2010 is shown in **Table 9-2**.

Table 9-2 Waste Collected for Year 2010 in Las Piñas

Month	Garbage Collected	No. of Trips
January	17,604	2,096
February	15,340	1,841
March	18,519	2,179
April	17,002	2,057
May	16,004	1,946
June	16,437	2,029
July	15,852	2,061
August	16,854	2,232
September	17,521	2,251
October	18,212	2,201
November	17,946	2,072
December	18,552	2,100
TOTAL	205,843	25,065

9.2.2 River Dredging Activities

River dredging is a responsibility for MMDA. **Table 9-3 (1/2)** and**9-3 (2/2)** Show the activity records in 2010 by District Office of First South Metro Manila Flood Control Operation district. Parañaque and Las Piñas are not planned for the activities at this moment.

Picture 9-1 Garbage in Waterways in Parañaque

1. Sun Valley Creek, Brgy. Sun Valley

July 12, 2010 Photo File: IMG_7521.jpg

2. Almanza Creek crossing Nicanor Abelardo St., Brgy. BF Homes

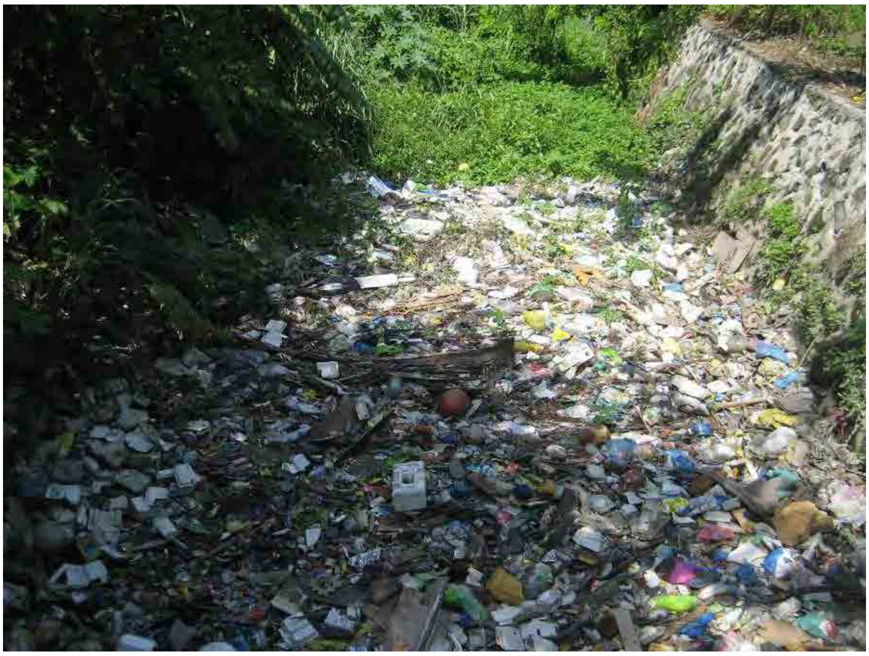
July 29, 2010 Photo File: P-0729-012.JPG

Picture 9-2 Garbage in Waterways in Las Piñas

L1. Inside BF Executive Village at bridge along Executive Ave., Brgy. Almanza Uno

August 21, 2010 Photo File: DSC01250.JPG

L2. Bridge along Colt Street at Canaynay Court, Brgy. Manuyo Dos



July 7, 2010 Photo File: LP-0707-004.jpg

Table 9-3 (1/2) Dredging Record in 2010 (1/2)

ACTIVITY	NAME/LOCATION	TARGET	ACCOMP. JAN.-SEPT.	OCTOBER				NOVEMBER				DECEMBER				ACCOMP. TO DATE		REMARKS
				WK 1	WK 2	WK 3	WK 4	WK 1	WK 2	WK 3	WK 4	WK 1	WK 2	WK 3	WK 4	QTY.	%	
Declogging of Drainage Laterals	MAKATI CITY DISTRICT I																	
	1.Edsa (Tripa Guadalupe)	1,000 l.m.	1,100				100			100						1,300	130.00	completed
	2.Buendia Ave.	4,000	3,300		200	200		200	100							4,000	100.00	completed
	3.SSH	1,000	1,000													1,000	100.00	Completed
	4. J.P. Rizal	500	600													600	120.00	completed
	5. Pasong Tamo	4,000	2,300				200	200	200	200	200	200	200	200	100	4,000	100.00	completed
	6.Arnaiz Ave.	500	1,100								100					1,200	240.00	completed/backjob
MAKATI DISTRICT II	7.Kalayaan Avenue	500	600										200	200		1,000	200.00	completed
	8.Magallanes Int.	800	700						100							800	100.00	completed
	9. Guadalupe-Pateros	300	300		100											400	133.33	completed
	10. C - 5	500	500											100	100	700	140.00	completed
	11.V.Cruz Ext.	300									200	100				300	100.00	completed
	12.Mckinley Road	300									200	100				300	100.00	completed
																-		
																-		
	TOTAL	13,700 l.m.	11,500	-	300	200	300	400	400	300	700	400	400	500	200	15,600	113.87	%
	PASAY CITY (Lone District)																	
	1. F.B. Harrison	3,000 l.m.	2,600						200	200						3,000	100.00	completed
	2. Taft Avenue	3,000	2,600			200	200							200		3,200	106.67	completed
	3. Aurora Blvd.	1,500	1,600									100	200			1,900	126.67	Completed
	4.EDSA	1,000	1,100								100				200	1,400	140.00	Completed
	5.Gil Puyat Ave.	1,200	1,200													1,200	100.00	Completed
	6.Domestic Road	1,000	1,000													1,000	100.00	Completed
	7.Roxas Blvd. Main	1,500	2,100		200	200	200	200			100					3,000	200.00	completed
	8. Mexico Road	600	800													800	133.33	completed
	9. Nichols															-		
	West Service Road	500	500													500	100.00	completed
	10.Libertad	500	900													900	180.00	completed
	11.Andrew Avenue	500	800													800	160.00	completed
	12.Ninoy Aquino	300	300													300	100.00	completed
	13.Mia Road	300	400													400	133.33	completed
																-		
																-		
																-		
	TOTAL	14,900 l.m.	15,900	-	200	400	400	200	200	200	200	100	200	200	200	18,400	123.49	%
	GRAND TOTAL	28,600 l.m.	27,400	-	500	600	700	600	600	500	900	500	600	700	400	34,000	118.88	%

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Table 9-3 (2/2) Dredging Record in 2010 (2/2)

ACTIVITY	NAME/LOCATION	TARGET	ACCOMP. JAN.-SEPT.	OCTOBER WK 1	OCTOBER WK 2	OCTOBER WK 3	OCTOBER WK 4	NOVEMBER WK 1	NOVEMBER WK 2	NOVEMBER WK 3	NOVEMBER WK 4	DECEMBER WK 1	DECEMBER WK 2	DECEMBER WK 3	DECEMBER WK 4	ACCOMP. TO DATE QTY.	ACCOMP. TO DATE %	REMARKS
Dredging/	WATERWAYS															-		
Desilting	1. PNR Open Canal	2,500	1,550	100	50	50	50	100	100	100	100	100	100	100	100	2,600	104.00	completed
of Open (Pasay)	2.Andrew Canal	250	300		50	50							50			450	180.00	completed
Waterways	3. Zanzibar	100	150													150	150.00	completed
	4. Sto Niño Creek	200	550	50	50										100	750	375.00	completed/backjob
(Pasay)	5.Est. Tripa de Gallina	1,000	1,150													1,150	115.00	completed
	6.Calatagan Creek	200	200													200	100.00	completed
	7.Maricaban Creek	200	300													300	150.00	completed
	8. Sta. Clara Creek	200			50	50	50		50							200	100.00	completed
	9.Cutcut Creek	200	200													200	100.00	completed
Makati Dist. I	10.Makati Diversion	200	250													250	125.00	completed
(Pasay)	11.Roxas Blvd.Canal	300	350													350	116.67	completed
Makati Dist. II	12.Makati Pateros	200	250													250	125.00	completed
	13.Maricaban Tributary	100	200													200	200.00	completed
	14.Balisampan Creek	200	450													450	225.00	completed
		5,850 l.m.	5,900	150	200	150	100	100	150	100	100	100	150	100	200	7,500	128.21	%
Requests/																-		
Collecting/	TRASH SCREEN #1		825	45	10	10	20	15	20	20	30	25	20	20	35	1,095		on-going
Hauling of	TRASH SCREEN #2		725	20	20	10	15	10	20	58	40	15	15	15	30	993		on-going
Garbages			1,550	65	30	20	35	25	40	78	70	40	35	35	65	2,088		
	Steel Grating	20 units	11													11	55.00	on-going
	Conc. Manhole	50	15									1		1	1	18	36.00	on-going
																-		
Request																-		
Declogging/Cleaning		3,000 l.m.	2100			200				200	200	200		200	300	3,400	113.33	completed
Special Project Repair of																		
Damaged Ridge	C5-East Serv. Road	20 l.m.	30													30	150.00	completed
																-		
Construction Roxas Blvd.of Crosspipe		10 l.m.	10													10	100.00	completed
Front Madrigal																-		
Fencing	Buendia Trash															-		
	Raake Screen 1 & 2	74.3 l.m.	74.3													74.30	100.00	completed
																-		
																-		
																-		

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9.2.3 Educational Programs

MMDA and LGUs are responsible for solid waste and river cleaning management, however, mainly because of budget problem, those activities are not sufficient. One of resolutions of the garbage problems, Paranaque City confronts 3R programs (solid wastes reduce, reuse and recycle programs). **Table 9-4** shows record of barangay solid waste management in year 2009 prepared by Solid Waste and Environmental Sanitation Office of Parañaque..

Regarding garbage collection and 3R activities, supports by the residents are essential to improve their activities. It will be eventually a part of river cleaning programs.

1) Educational Activities

The garbage problems in Metro Manila would partially depend on the residents' behavior to the garbage management, that is, it's a matter of disciplines by childhood manner education. Therefore, the manner education in elementary schools is effective to improve the garbage control. This kind of curriculum in elementary school should be compulsory.

Preparation of textbooks teaching damages to eco-system, ordinal human life and health shall be considered as an educational program by relative agencies and LGUs. The principal contents of the text would be;

- Management Process of the city garbage,
- Pollution and damages caused by garbage jettison out of houses,
- Garbage as resources,
- Garbage management in the Households,
- Manner for garbage control, etc.

2) Preparatory Activities for Encouraging the Education Program

Before the action described in Item 1), the following actions would be recommended.

(1) Clean-up Action by Elementary School Students

Collecting garbage in the town or creeks and esteros by elementary school students shall be conducted as one of the school curriculum once a month. The cleaning area should be defined in the school district. The necessary tools like plastic bags, garbage pick-up tools should be supplied by the LGU. Recyclable and reusable solid wastes should be segregated and collected, and consolidating points. The collected garbage shall be hauled by LGU and counter value for the activities should be paid to the school.

Table 9-4 Barangay Solid Waste Management in Parañaque in year 2009

District Ⅰ

Barangay	Population	Compliance RA 9003 (%)	Waste Generation (Tons /day)	Recycable Waste (Tons in Ave)	Biodegradable Waste (Tons /day)	Residual Waste Ave. Per Day (Tons)	Trucks per day/week	D2D Collection (%)	Compost Project (K/Mon.)	No. of Junkshop	MRF
Baclaran	27,720	80	16.63	4.65	0.30	55	5/D	90	100	4	4
Tambo	26,885	60	16.13	4.35	0.15	12	3/D	80	100	4	3
Don Galo	9,649	70	5.78	1.70	0.50	4	1/D	90	80	1	MRS
Sto. Niño	29,691	80	17.81	5.34	0.80	40	1/D	90	300	4	1
La Huerta	7,733	40	4.63	1.20	0.05	4	1/D	95	-	0	1
San Dionisio	63,767	80	38.26	9.94	0.27	25	4/D	80	-	8	1
San Isidro	64,011	30	38.40	10.33	0.30	24	6/D	90	100	10	1
Vitalez	4,117	80	2.47	0.69	0.35	8	2/D	96	500	0	MRS
SUB TOTAL	233,573	65.62	140.11	38.20	2.72	172*		88.88		31	13

* Average volume includes Comercial Industrial wastes

District Ⅱ

Barangay	Population	Compliance RA 9003 (%)	Waste Generation (Tons /day)	Recycable Waste (Tons in Ave)	Biodegradable Waste (Tons /day)	Residual Waste Ave. Per Day (Tons)	Trucks per day/week	D2D Collection (%)	Compost Project (K/Mon.)	No. of Junkshop	MRF
San Antonio	59,045	53	35.42	9.21	0.80	20	5/D	90	-	11	1
Marcelo	29,780	60	17.86	5.17	0.60	40	10/D	96	400	8	1
Sun Valley	37,564	65	22.43	6.30	0.60	14	4/W-2DB	85	600	9	7
San Martin	24,923	80	14.95	6.12	0.30	9	1/D	90	250	25	1
Merville	24,923	60	10.88	2.93	0.47	8	8/D	85	-	2	1
Moonwalk	52,645	40	31.58	7.75	0.40	14	4/W-DB	90	-	5	1
Don Bosco	44,865	80	26.91	8.07	0.80	56	14/D	95	800	3	4
B.F.	85,110	60	51.06	12.76	0.35	64	16/D	85	300	1	1
SUB TOTAL	358,855	62.25	211.09	58.31	4.32	225*		89.50		64	17
Grand Total	592,428	63.94	351.20	96.51	7.04	397*		89.18		95	30

* Average volume includes Comercial Industrial wastes

* Average volume includes Comercial Industrial wastes

Legend:
MRF: Materials Recovery Facility
MRS: Material Recovery System
D2D: Door to Door Collection

Prepared by Solid Waste and Environmental Sanitation Office

(2) Supporting Plan of the Clean-up Action

The purpose of clean-up activities by elementary school children is to identify them;

- The current situation of garbage jettison-out,
- Garbage pollution in the town,
- Necessity of the manner not to dump the garbage into public spaces or waterways,
- Garbage as resources,
- Necessity of segregation of the garbage, and
- How much man-power and energy is required to manage the garbage dumped improperly

In order to assist and encourage the actions, the following facilities should better provide to the action group or LGU.

a) Consolidation Container (**Picture 9-3**)
   10 sets Net type for segregation
b) Consolidation Container Station (**Picture 9-4**)
   2sets Standalone Steel Box Type (0.8mH x 1.6mW x 3.2mL)
c) Hauling Track (**Picture 9-5**)
   1 set 2 tons, Arm roll Type

Two consolidation containers are located in appropriate space in the school district and consolidate the garbage collected by the school children. Transportation track take on the containers to the pick-up place designated by LGU.

Picture-9-3　Consolidation Container (Net Type)

Picture 9-4　Consolidation Container Station (0.8mH x 1.6mW x 3.2mL)

Picture 9-5　Hauling Track (Arm Roll Type, 2t)

9.2.4 Onsite Treatment and Dredging Program

There are several wastewater treatment systems installed in the waterways, street drainage culverts or under communal roads, such as Bio Rotary, Shimanto-river system, etc. These systems would be used temporally or permanently in the rural areas. These systems are of cheap construction cost, of easy installation in the local areas, and of localized materials mostly used, however, as the preparatory survey phase 1 report pointed, these systems are unlikely to be applicable to Metro Manila. The reasons of it revealed in the Phase1 are because of high population density, huge amount of garbage in the waterways, huge amount of pollution load, and difficulty to get close cooperation. In Parañaque and Las Piñas such kind of on-site facility is quite difficult to be installed. Because adding to the reasons mentioned above, the whole areas at upstream districts, there is difficult to find the space to install the facilities and additional new sewer storm pipe, and septic tanks are under terrible maintenance conditions. The creeks, esteros, street drainages and rivers are of poor drainage capacity; lots of garbage in the water ways, insufficient dredging resulting much silt accumulation on the water bed, program makes the capacity degrade. Thus any obstruction should not be installed in the waterways.

The project plan recommends installing conversion manholes at the outfalls (discharge points at the far-end of the drainages to the final catchment) because of combined sewer collection system to be applied. In case that any areas are found difficult to reach the interceptors or uneconomical to connect to the central sewage treatment plants, a small underground STP for local areas might be adopted. Eventually on-site sewage facility would not be possible.

As shown in **Table 9-3**, MMDA dredging program is on request base and insufficient budget is one of difficult situations to make the activity encouraging. Priority of dredging should be made on the receiving body of STP already completed.

Picture 9-6 Dredging Activity by MMDA

9.3 Promoting Sewerage System Development

In order to develop sustainable sewerage treatment system, cooperation and perception of residents for sewerage treatment systems are essential. Therefore constant information and publication of sewerage treatment systems should be made to the current stakeholders or the prospective stakeholders. The sewage treatment plants should be used or planned to encourage such information and publication activities.

9.3.1 Educational Plant Tour Program

The sewage treatment plant under operation should be open to visitors, or residents to make them get deeper comprehension of the system importance. As such, Maynilad should plan to build plant tour route with explanatory pictures or brochures in site, and issue the publication of the tour information.

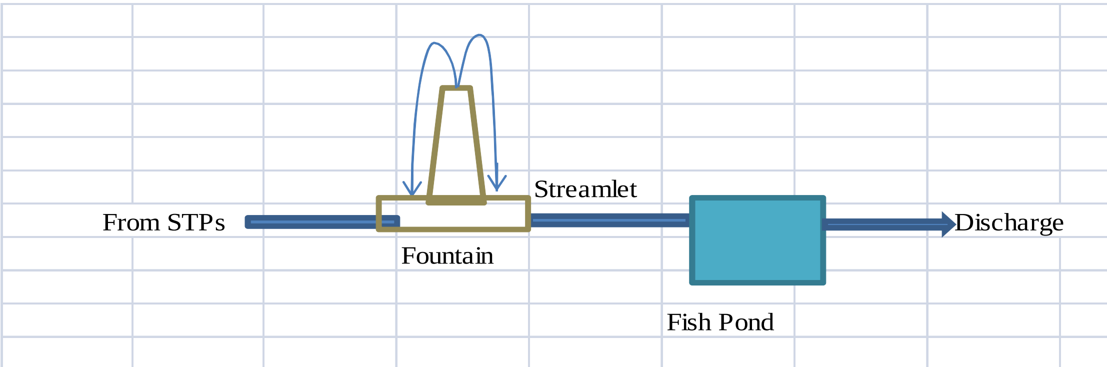
9.3.2 Water Park in Sewerage Treatment Plant

In order to give the plant tour visitors good impact to the sewerage treatment systems, a small water park should be constructed at the end of tour course. That would emphasize and visualize the visitors sufficient functioning of the systems for cleaning the wastewater up to the effluent water quality of DENR standards.

1) Water Park Conception

A water park shall be constructed in the remaining space of the sewage treatment plant. This park consists of tour road, plants, greensward, fountain, streamlet, and a small pond having small fish. Streamlet is the passage of treated water into river.

Figure 9-1 Water Park Conception



2) Treated Water Reuse

The treated water is used for the water park. The water in the park should be safe if the visitors touch. Thus the treated water shall be disinfected and filtered before supplying to the park. This will show the visitors sewage water reusable. Because of hygienic reason, the filtration should be physical rapid filter with capacity of $100m^3/d$ instead of sand filter.

The flow of the rapid filter connected to the sewerage treatment plant is shown in **Figure 9-2** and $100m^3/d$ rapid filter outline is shown in **Figure 9-3**

Figure 9-2 Rapid Filtration Flow

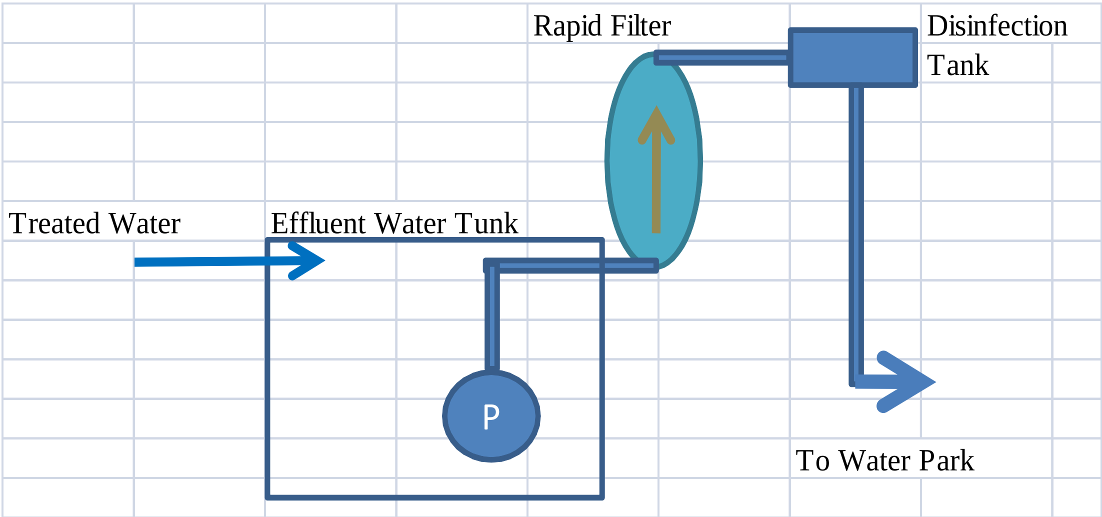
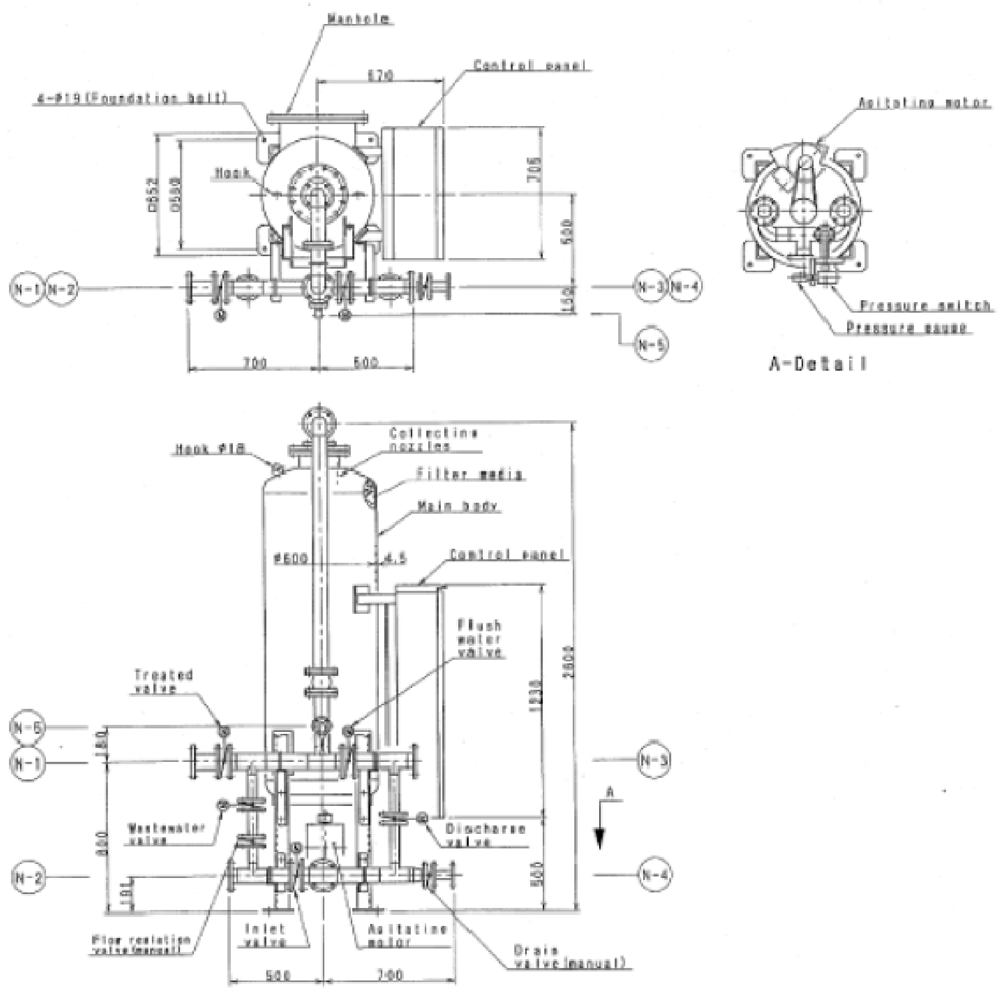


Figure 9-3 Rapid Filtration Equipment (Plastic Fiber Media)



9.4 River Cleaning Supporting Program

The sub-project program supporting the sewerage system implementation project planned in Parañaque and Las Piñas Cities are wrapped up hereunder. This sub-projects aims for supporting the sewerage systems, however, projects themselves should better be implemented separately from the main projects. Thus budget for the program would preferably be donated by JICA Aid (Grant base), because the programs proposed have direct connections to other relative programs promoted by LGUs, MMDA, DENR, etc, and the sewerage project shall be done by MWSI (private entity).

a) Supporting Program for Hygienic Improvement of Poverty Families

Establishment revolving fund for poor families' hygienic improvement: LGUs, DOH

b) Educational Programs
   Garbage Collection and Recycle supporting Program: LGUs, MMDA, DepEd
   School campaign program for environmental education: LGUs, DepEd
   School excursion program for eco-tour: LGUs, DOE, MWSI.

Program items and budget estimates are shown in Annex 5.

10. Mitigation Measures of Climate Change integrated in the Project

This Section discusses the generation rates of sewage sludge, digestion gas and gas power. General estimates of these rates are presented including the optimistic digestion gas volume generated in the MWSS service area on the basis of population. The effectiveness of the Project on climate change is discussed with an estimate of total reduction of greenhouse gas and the possibility of CDM application

Treatment process of sewage water is basically classified broadly by physical-chemical process and biological process. Because of difficulty of treatment of dissolved solid by physical process, biological wastewater treatment process is prevailingly used. Biological treatment system is also divided into two processes, anaerobic and aerobic process. For the sewage treatment system, aerobic treatment process is generally applied. Sewage sludge generated in the treatment process are basically thickened, dewatered or digested before dewatering, and finally incinerated or land-filled. As mentioned in Section 6.4, sewage sludge is in case used as the materials for production of composted fertilizer, and though it still has some economical problems, sludge itself could be used to product construction materials by sludge dissolution process. The sewerage treatment services in MWSI business area is currently at low level (less than 15% in 2020). Because sewage sludge generated in the sewage treatment process will increase as developing the sewerage treatment systems in the MWSI jurisdictional areas, sewage sludge treatment system shall be essential to incorporate into the sewage treatment plants otherwise to be constructed solely outside of the plants, in order to reduce and treat the sewage sludge. Therefore, sewage sludge treatment systems shall be established together with digesting systems, and at the early sewerage system developing stage, inflaming the methane gas or using it as bio-energy for in-site power generation system are viable, in aspect of the measures of economical and realistic sludge reduction systems, and devoting to mitigation of climate change.

Sewage sludge contains comparatively much organic materials, and it is well known that fermentation heat is emitted under biological aerobic degradation. And methane gas is possible to use as energy source, and dry cake of sewage sludge itself could be combustion material. That is, internal energy stored in the sludge as organic material can be converted to outside energy source. Sludge digestion gas includes 60% and more methane gas, and methane gas decomposition into CO_2 and H_2O is effective 21 times for reduction of greenhouse gas effect than reduction of GHG emission, (that is, GWP_{CH4}=21GWP_{CO2}). Therefore, as one of sewage sludge management process, sludge digestion and utilization of sludge gas are recommended. These utilizations eventually reduce methane gas emission from sewage sludge degrading process, that is, the sewage sludge utilization itself is one of the climate change mitigation countermeasures.

10.1 Sewage Sludge Generation Rate

The sludge solids quantity available from sewage flow is generally anticipated by the following expression.

$Qs = If \times P \times K \times Sq \times 10^{-6}$
$Ql = Qs \times 1/d$
Where

- Qs: solid sludge rate (t/d)
- If: influent sewage water rate (m^3/d)
- P: average concentration of inlet SS (mg/l)
- K: sludge scrubbing coefficient (0.9 or (1- r/P), r; effluent water quality standard)
- Sq: sludge producing coefficient (1.0)
- Ql: liquid sludge rate scrubbed (m^3/d)
- d: thickened sludge concentration (0.015 to 0.025)

Assuming that influent water quality is 200mg/l.BOD_5, and effluent water quality standard is 50mg/l or less in the project areas, Qs and Ql per 1 m^3/d of wastewater are calculated as follows,

$Qs = 1 \times 200 \times (1\text{-}50/200) \times 1 \times 10^{-6} = 150 \times 10^{-6}$t/d
$Ql = 150 \times 1/ (0.025 \text{ to } 0.015) \times 10^{-6} = 0.6 \text{ to } 1.0 \times 10^{-2} m^3/d$

Therefore sewage sludge generation rate is expected **0.6 to 1.0%** of influent flow rate. This rate depends on influent water quality and effluent water quality standard.

10.2 Sludge Digestion Gas Generation Rate

The digesting gas volume produced from activated sludge is ordinarily expected and calculated by the following expression;

Gd = Gm x Ql
Where
Gd: digestion gas volume (m^3/d)
Gm: multiplier

The multiplier Gm is assumed around 7 times, therefore the gas volume generated by digestion sludge is to be about 7 times the liquid sludge volume. Thus Digestion gas production volume per 1m^3/d influent flow is;

$Gd = 7 \times Ql = 7 \times 0.6 \text{ to } 1.0 \times 10^{-2} m^3/d = (4.2 \text{ to } 7) \times 10^{-2} m^3/d$

Therefore digestion gas production rate is expected 4.2 to 7.0% of influent flow rate. The followings are field investigations of sewage sludge digestion gas production.

(Case-1) Y sludge center in Yamagata, Japan

	Year of					
	2002	2003	2004	2005	2006	Average
Ql (m^3/y)	236,046	237,492	228,733	255,754	243,183	240,241
Gd (m^3/y)	1,267,054	1,470,755	1,474,107	1,417,605	1,449,690	1,415,842
Gm	5.4	6.2	6.5	5.6	6	6

Separate Collection Sewer

(Case-2) D sewage treatment center in Ishikawa, Japan

	Year of			
	2004	20005	2006	Average
Ql (m^3/y)	25,333	25,827	26,428	25,863
Gd (m^3/y)	146,086	170,692	210,725	175,834
Gm	5.8	6.6	7.9	6.8

Separate Collection Sewer

(Case-3) K sewage treatment works in Singapore

1991 Oct to 1992 Sept	Ql (m^3/mth)	Gd (m^3/mth)	Gm
91/10	16,220	102,411	6.4
11	16,730	101,890	6.1
12	19,700	84,003	4.3

92/1	17,670	84,890	4.9
2	15,220	70,526	4.7
3	19,580	98,426	5.1
4	17,020	85,519	5.1
5	18,210	90,831	5.0
6	17,890	120,724	6.8
7	19,050	116,320	6.2
8	18,880	112,220	6.0
9	18,640	115,771	6.3
Average	17,730	98,626	5.6

Separate and Combined Sewer

Average Gm value of three field data without three records in December 1991 to February 1992 in Singapore, is 6.3, therefore pessimistic Gm of 6.0 and optimistic 6.5 would be predicted.

10.3 Sludge Digestion Gas Power Generation

The sludge that is generated during sewage treatment is also regarded as a biomass resource, and by effectively utilizing the digestion gas that is obtained by anaerobically digesting sewage sludge to generate electricity, not only can fossil fuels be saved on but also a contribution can be made to cutting down on green house gas emission. For example, it is said that approximately 30% of a treatment plant's electricity consumption can be covered through the introduction of power generation from digestion gas.

Digested Gas includes methane gas in percentage of 60 to 65%. Therefore decomposition of the gas by incineration or energy for power generator operation is much effective to reduce greenhouse effect by methane gas generated in the process of natural degradation. Especially digested gas generation would, as said above, contribute to save energy source like fossil fuel. Sewage sludge digestion gas is prevailingly by methane fermentation method, that is, digestion in the digesting sludge tank. The large scale digesting tanks also work as cushion tank against process disturbance, so that operation and maintenance staff could be absorbed in the daily works. Digested sludge is easily composted, and has superiority in aspect of immunological security against virus or pathogenic bacteria. In case of incineration of digested sludge, smaller facility is required enough for reduced volume after methane fermentation, and also digested sludge itself is very stable matters under appropriate conditions like dewatered or as acid soil, and shows sluggish turnover at least several decades. As such, as prevention of climate change and construction of a recycling-oriented society become important issues, attention is being increasingly directed towards biomass, which refers to organic resources derived from living organisms.

10.3.1 Current Conditions of Digestion Gas Power Generation

Digestion of sewage sludge has conventionally been implemented as one means of sludge treatment in order to stabilize and reduce the volume of sewage sludge. Anaerobic digestion involves decomposing and stabilizing sewage sludge by means of anaerobic microorganisms such as methane bacteria, etc., and such treatment generates flammable gases such as methane, etc. The composition of the digestion gas is generally as follows.

Table 10-1 Composition of Digestion Gas (%)

CH_4	CO_2	H_2	H_2S	O_2	N_2
60 to 65	33 to 35	0 to 2	0.01 to 0.02	0	0 to 3

Concerning methods of use of digestion gas, it has conventionally been used for heating digestion tanks and as an auxiliary fuel for sludge incinerators; however, digestion gas power generation in a gas engine was developed for practical application during the 1980s with a view to saving on treatment plant power costs and making effective use of resources. After that, due to the decline in the price of petroleum, revision of sludge treatment methods and increases in the maintenance costs of digestion gas power generation facilities and so on, this approach has failed to become very widespread.

However, against the background of growing interest in climate change countermeasures and energy saving in recent years, digestion gas power generation is once again attracting attention.

10.3.2 Digestion Gas Generation Rate

Digestion gas power generation typifies the positive utilization as energy of digestion gas generated in the anaerobic digestion of sludge. This technology was first established in the 1950s.

Concerning the conversion of methane gas – an internal energy in sludge – into energy based on the anaerobic digestion process, it has been proved in numerous data that 1 m^3 of digestion gas can be generated from the decomposition of 1 kg of organic solids, and this corresponds to generation of approximately 0.6 m^3 of methane gas. In other words, the internal energy of sludge (approximately 5,500kcal/VSkg) is directly converted into methane gas. However, because the decomposition rate of sludge organic matter in anaerobic digestion is limited to approximately 50%, the generated amount of methane gas per kilo of inserted volatile solid (VS) is approximately 0.3 m^3.

Table 10-2 shows data on the amount of methane gas generated in anaerobic digestion of sewage sludge, and this indicates that the calorific value of sludge is converted to methane gas calorific value at efficiency of 70~30%. In other words, on average half the internal energy of sludge is converted to methane gas.

The composition of digestion gas is approximately two thirds methane gas and one third carbon dioxide while other constituents exist in negligible amounts. Accordingly, the calorific value of digestion gas can be calculated based only on methane gas. Until now the methane gas generated in digestion tanks has only be used for heating tanks, however, following the introduction of gas power generation, cogeneration systems have been developed, thereby enabling a higher degree of energy utilization to be achieved. In gas power generation systems, the most important thing concerns whether or not the collected calorific value is sufficient for heating tanks, however, an effective countermeasure in this respect is to reduce the quantity of inserted sludge (that requires heating) by raising the concentration of the inserted sludge.

Table 10-2 Example of the Measured Quantity of Methane Gas Generation from Sludge based on the Anaerobic Digestion Method

Test sample sludge	Generated gas per inserted VS (l/g)	Generated methane gas per inserted VS (l/g)	Methane content ratio (%)	Methane gas calorific value per inserted solids (cal/g)
1-P’ry sedimentation	0.688	0.389	56.5	3,120
2-Excess	0.478	0.306	64.0	2,470
2-P’ry sedimentation	0.349	0.238	68.2	1,400
2-Excess	0.274	0.179	65.3	1,180
3-Mixing	0.393	0.243	61.8	1,560
3-Excess	0.385	0.238	61.8	1,760

National Land and Transportation Ministry, Sewerage Dpt (Japan)

In order to confirm the amount of energy recovered from the gas power generation system, estimation is conducted here assuming the relationship of 150g of generated sludge for every 1 m^3 of treated sewage. Assuming the sludge contains 67% organic matter, the said quantity of sludge will contain 100g of organic matter, and since half of this is gasified, the generated amount of digestion gas is $0.05m^3$. Accordingly, the generated amount of electric power extruded from 1 m^3 influent water value will be 90 kcal or approximately 0.1 $kWh/m^{3,}$ that is, **1.43 kWh/m^3** of methane gas base (assuming sewage sludge concentration of 1%, methane concentration of 60%)**.** Since treatment plants use around 0.3kWh of electric power on average in order to treat 1 m^3 of sewage water, the electricity provided by the gas power generating system will account for one-third of the plant's power requirement. The field investigations are studied hereunder.

The data shown in **Table 10-3** are extracted from field data of dual fuel engine generators operated in Japan.

Table 10-3 Gas Engine Generation Power

Generating Voltage (kv)	Generator Capacity (kw)	Gas Consumption		Notes
		Nm^3/h	$Nm^3/100kw$	
6.6	200	53.2	26.6	13A Gas
6.6	550	154.0	28.0	13A Gas
6.6	600	175.3	29.2	13A Gas
6.6	725	210.2	28.9	13A Gas
6.6	956	258.0	27.0	13A Gas
Average	606	170	28.0	-------

For 60% concentration of methane gas in digesting gas, net energy available is usually 40% of natural gas (13A). Thus, digesting gas generation power can be calculated as follows;

$100kw/28Nm^3 \times 0.4 = 1.43\ kw/m^3$ (60%)
$100kw/28Nm^3 \times 0.4 \times 65/60 = 1.55\ kw/m^3$ (65%)

The relations between digesting gas concentration and gas generator output has been elucidated by the field study with a 250kVA digesting gas generator at S STP in Kyusyu district in Japan during 1984 to 1989.The empirical formula used is as follows;

$P_G = 0.0398d - 0.6111$

Where

P_G: digesting gas power rate (kWh/m^3)

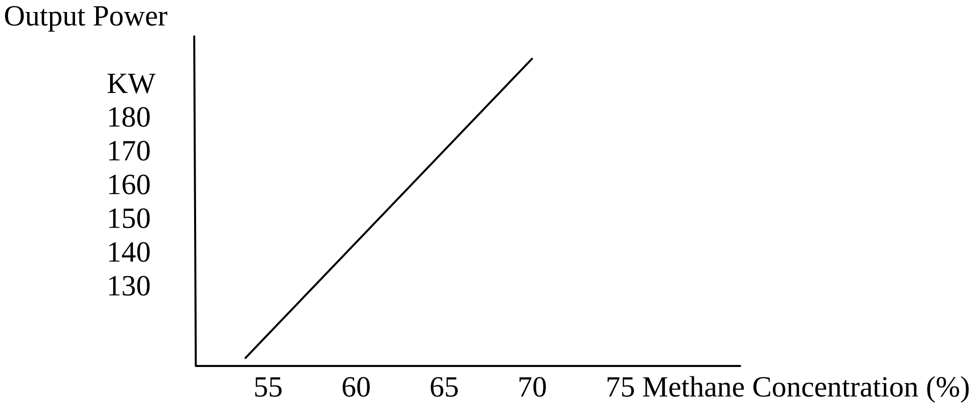
d: digesting gas density (%)

Thus the gas generation power rate is;

$0.0398 \times 60 - 0.6111 = 1.8\ kWh/m^3$ (60%)
$0.0398 \times 65 - 0.6111 = 2.0\ kWh/m^3$ (65%)

Actually, the STP shows the relation curve of gas consumption and generation power rate with methane gas fuel supply of $90m^3/h$ as follows.

Figure 10-1 Relation Curve with Methane Gas and Output Power



In case of field data of K STW in Singapore, the data was recorded for one year under business operation. The data is as follows;

Table 10-4 Sludge Gas Production and In-plant Power Generation

1991/10 to 1991/9	Sludge Gas		Diesel Oil Consumption (l/mth)		In-plant Generation (kWh/mth)	
	Produced (m3/mth)	Used (m3/mth)	Diesel generator	Dual fuel generator	Diesel generator	Dual fuel generator
91/10	102,411	101,980	20,850	7,815	80,570	244,120
11	101,870	102,089	18,765	8,062	71,380	249,880
12	84,003	82,192	32,804	8,220	120,530	207,540
92/1	84,890	84,356	21,945	7,129	82,720	203,300
2	70,526	70,166	32,067	4,346	123,760	153,960
3	98,426	92,930	18,273	7,340	75,300	231,680
4	85,519	83,125	21,108	5,372	79,990	189,320
5	90,831	91,269	31,764	5,678	109,310	207,430
6	120,724	118,924	7,531	7,795	32,950	292,110
7	116,320	112,543	9,959	7,056	38,580	273,415
8	112,220	104,255	9,540	5,810	34,880	249,711
9	115,771	109,910	119,92	8,440	42,250	254,000
Average (mth)	98,626	96,128	19,716	6,922	74,351	229,705
Average (day)	3,242	3,160	648	227	2,444	7,552

From **Table 10-4**, gas generating power in the plant could be calculated by deducting diesel power from dual fuel power as follows;

Straight diesel generation power	2,444/648 = 3.77 kWh/l
Dual fuel engine generation power by oil	3.77 x 227 = 855.8 kWh/d
Sludge gas generation power	7,552 – 855.8 = 6,696.2 kWh
Sludge gas generating power rate	**6,696.2/3,160 = 2.1 kWh/m^3**

According to the annual works performance report of 1989 to 1991, the concentration of methane in sludge gas was 70.9 % on an average and the calorific value of the gas was 25.6MJ/m^3.

The dual gas engine usually covers 25 to 30 % of input gas energy to electricity, thus, the anticipated generating power is;

$25.6 \times 10^6 \times (0.25 – 0.30) \times 2,778 \times 10^7 = 1.78 – 2.13$ kWh/m^3

According to the relation of digesting gas concentration and generating power elucidated in S STP in Kyusyu, gas generating power with methane concentration of 70.8% is calculated as follows;

$Pg = 0.0398d – 0.6111 = 0.0398 \times 70.9 – 0.6111 = 2.1$ kWh/m^3 (70.9% gas concentration)

That means;

1.78 kWh/m^3 in case of 60% gas concentration
1.93 kWh/m^3 in case of 65% gas concentration

The digesting gas generation power rates procured in field and logical calculations are warped up in **Table 10-5**.

Table 10-5 Sludge Digesting Gas Generating Power Rate

Methane Gas Concentration (%)	Field Data (kWh/m^3)			
	Laboratory	13 A Gas Engine	S STP in Kyusyu	K STP in Singapore
60	1.43	1.43	1.8	1.78
65	-	1.55	2.0	1.93

The averages of the data except 13A gas generator, the power generation rates of digesting gas are:

Methane Concentration of 60% 1.67kWh/m^3
Methane Concentration of 65% 1.83kWh/m^3

Therefore the sewage sludge digesting gas power generation rate/d by digesting gas volume in the project area shall assume as follows.

Optimistic generation power rate 1.8 kWh/m^3
Pessimistic generation power rate 1.6 kWh/m^3

10.3.3 Types and Features of Power Generation Systems

In addition to the conventional method of gas engines, micro gas turbines and fuel cells are used as generating methods applicable to digestion gas power generation. **Table 10-3** gives a comparison of each power generating system.

1) Gas Engine

The gas engine was the first generating system practically developed for using digestion gas. Engines are available in various sizes from large to small and are the most common system for generating power from digestion gas.

Digestion gas engines previously incurred high maintenance costs because of the short service life of engine parts and the NOx removing catalyst. However, it has recently discovered that digestion gas contain traces of impurities (siloxane: organic silicide) that lead to the generation of silica (SiO_2) during combustion inside engines, and it is now forecast that digestion gas power generation will be introduced increasingly to small and medium-scale treatment plants, which were previously unable to introduce such systems due to economic reasons.

2) Micro Gas Turbine

The micro gas turbine is basically based on the same principles as the large gas turbine, however, it achieves relatively high power generating efficiency through adoption of a regenerating cycle. Moreover, the number of components has been reduced through the adoption of air bearings and omission of decelerator, etc. through generator coupling, and this has led to the improvement of reliability and maintainability and reduction of equipment maintenance costs.

Furthermore, since micro gas turbines like gas engines are power generating systems that entail combustion, it is necessary to remove silica produced during combustion of siloxane in digestion gas in order to prevent damage to engine components.

3) Fuel Cell

Fuel cells are environmentally friendly, have high generating efficiency and can also maintain high efficiency even at partial load.

Depending on the type of electrolyte, fuel cells are divided into the following types: a) phosphoric acid type (PAFC), b) molten carbonate type (MCFC), c) solid oxide type (SOFC), and d) proton-exchange membrane type (PEFC). The phosphoric acid fuel cell has been practically developed to use digestion gas as fuel.

Basic composition of the phosphoric acid fuel cell generating system using digestion gas as fuel has similar specifications to city gas systems. It is composed of a fuel reformer for converting methane to hydrogen, etc., and a CO transformer for converting carbon monoxide to hydrogen.

Since hydrogen sulfide deteriorates the reforming catalyst, it is necessary to eliminate it to the order of ppb. Although the battery is not affected by siloxane, because ammonia in fuel reactions with the phosphoric acid and builds up to impact the fuel cell characteristics, it is necessary to remove it in advance.

Table 10-6 Comparison of Each Digestion Gas Power Generating System.

	Gas Engine	Micro Gas Turbine	Fuel Cell
Handling of digestion gas	The first system developed for use with digestion gas; this is the most common system with cases of practical application at 18 locations.	A digestion gas specification turbine has been commercially developed and is now undergoing demonstration testing.	The phosphoric acid fuel cell has been practically developed for use with digestion gas and has been introduced to 2 locations.
Generated output (kW)	50~1,200	28~100	100~200
Power generating efficiency (%)	30~35	25~30	35~40
Overall efficiency (%)	70~80	70~80	70~80
Form of heat recovery	Hot water or hot water + steam	Hot water or steam	Hot water or hot water + steam

Main harmful components	Hydrogen sulfide Siloxane	Hydrogen sulfide Siloxane	Hydrogen sulfide Ammonia

10.3.4 Gas Engines and Micro Gas Turbines Composition for Digestion Gas Power Generation

Digestion gas is used as fuel in order to turn a gas engine or micro gas turbine and operate a generator. Concerning waste heat recovery, hot water is recovered by means of a heat exchanger and boiler. It is necessary to store the digestion gas in order to ensure stable power generation.

Outline of Equipment Composition is as follows

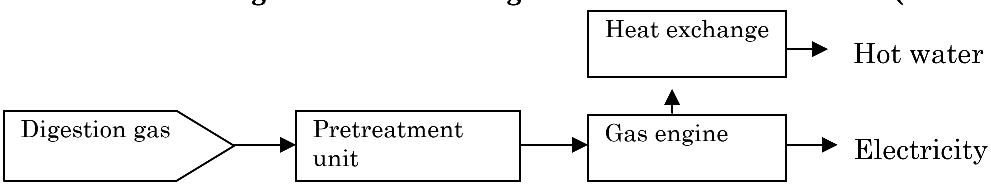
1) Gas Engine

Gas engines were the first power generating system to be practically developed for use with digestion gas; they generally have capacity of between 100~1,000 kW and they are the most commonly used power generation systems that utilize digestion gas.

Digestion gas engines previously incurred high maintenance costs because of the short service life of engine parts and the NOx removing catalyst. However, it has recently discovered that digestion gas contain traces of impurities (siloxane: organic silicide) that lead to the generation of silica (SiO_2) during combustion inside engines.

As a result, it has become possible to take steps to remove siloxane in digestion gas, and it is now forecast that digestion gas power generation will be introduced increasingly to small and medium-scale treatment plants, which were previously unable to introduce such systems due to economic reasons.

Figure 10-2 Flow of Digestion Gas Power Generation (Gas Engine)



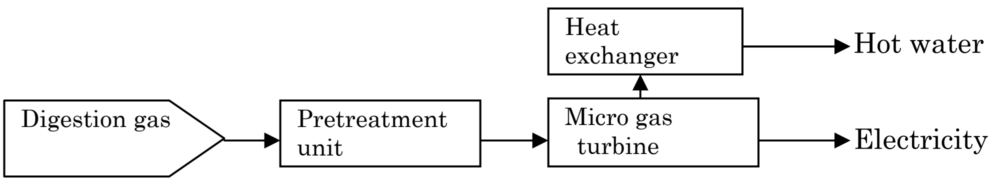
Pretreatment unit: This removes siloxane by means of an activated carbon filter.
Gas engine: This combusts the digestion gas and turns an engine in order to generate electricity.
Heat exchanger: This conducts heat exchange between the jacket cooling water and exhaust gas and supplies hot water.

2) Micro Gas Turbine

The micro gas turbine is basically based on the same principle as the large-scale gas turbine, and through adopting a regenerative cycle it achieves relatively high generating efficiency even at small capacity of 100 kW or less. Moreover, the number of components has been reduced through the adoption of air bearings and omission of decelerator, etc. through generator coupling, and this has led to the improvement of reliability and maintainability and reduction of equipment maintenance costs.

Furthermore, since micro gas turbines like gas engines are power generating systems that entail combustion, it is necessary to remove silica produced during combustion of siloxane in digestion gas in order to prevent damage to engine components.

Figure 10-3 Flow of Digestion Gas Power Generation (Micro Gas Turbine)



Pretreatment unit: This removes siloxane by means of an activated carbon filter.
Micro gas turbine: This combusts the digestion gas and turns an engine in order to generate electricity.
Heat exchanger: This conducts heat exchange with exhaust gas and supplies hot water.

3) Comparison of General Features

The gas engine drives a generator to generate and supply electricity, while at the same time waste heat from the waste gas and jacket cooling water is recovered in the shape of hot water and is used in air conditioning and hot water supply, etc. Since the power generating efficiency is high and the ratio of thermal output compared to power output is small, this system is suitable for facilities that have high electricity demand.

Meanwhile, the micro gas turbine is gaining attention as a small-scale gas cogeneration system that is compact and has high energy efficiency. Compare to a gas engine that has equivalent generating capacity, it is small and enables the cogeneration system to be made more compact; moreover, thanks to its simple structure and limited number of components, maintenance is easy.

Generally speaking, the gas engine has power generating efficiency of 25~35%, waste heat efficiency is 40~55%, and the overall efficiency is approximately 80%. In contrast, the micro gas turbine has power generating efficiency of 10~20%, however, thanks to the regenerative cycle technology that utilizes waste heat from the turbine, this can be improved to around 30%, which is similar to that of gas engines and diesel engines in the same class. Furthermore, compared to engines, because the micro gas turbine is characterized by a large quantity of waste heat and high waste heat temperatures, it is possible to obtain high overall thermal efficiency of 80~90% through collecting this waste heat.

10.3.5 Digestion Gas Fuel Cells

Gas engine or micro turbine power generation systems based on burning digestion gas to rotate gas engine or turbine are used to run the electric power generator.

This power generating method entails converting chemical energy into thermal energy and then converting the generated kinetic energy into electrical energy. Accordingly, some loss occurs in each process and this diminishes the amount of final useful energy.

Meanwhile, fuel cells enable electricity to be directly obtained from the chemical reaction of fuel. Thus they entail a smaller loss and enable a higher amount of useful energy.

Moreover, since conventional power generating systems entail transmission loss from power plants, the electric energy that can be finally used is low at around just 35%. In contrast, since fuel cells can be installed at locations where electricity is used, this transmission loss is negated; moreover, since the waste heat from fuel cells can also be utilized, this means that 80% of the available energy is utilized.

1) Principle

Utilizing the reverse principle of water electrolysis, fuel cells generate electricity through causing an electrochemical reaction between hydrogen obtained from digestion gases and oxygen taken from the atmosphere.

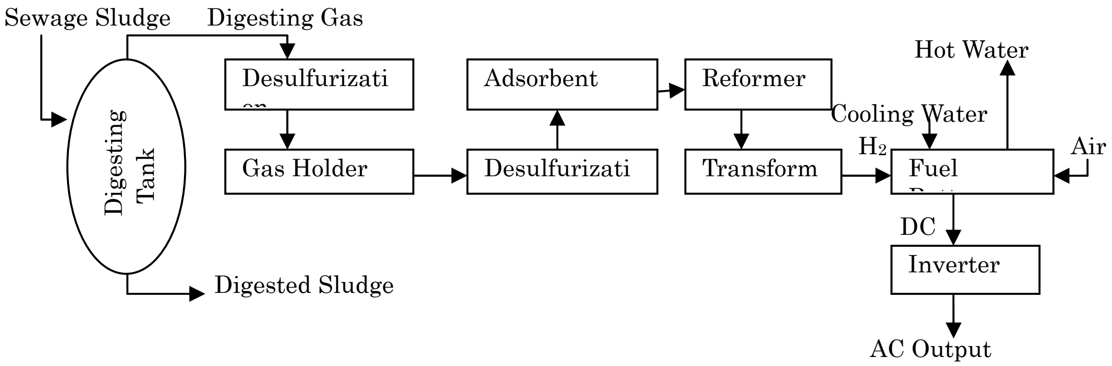
A fuel cell is composed of a cell stack, i.e. cells arranged in a pile. The cell has a fuel pole and an air pole. The hydrogen required for reaction passes through the fuel pole, while oxygen passes through the air pole. The hydrogen is converted into protons as the catalyst in the electrode causes electrons to split off, and since electrolyte only allows ions to pass, the separated electrons are discharged out. The protons moving through the electrolyte react with oxygen that is sent to the electrode on the opposite side and electrons returning via cable from outside (external circuit) to become water. This passage of reaction-related electrons through external circuits constitutes current flow, i.e. generation of electricity.

Moreover, because impurities such as sulfur compounds included in digestion gas diminish the efficiency and service life of the reformer, it is necessary to remove them from the supplied digestion gas.

2) Outline of Equipment Composition
3)

In fuel cells, digestion gas taken from the gas holder is passed through a pretreatment device in order to remove impurities and produce high concentration methane gas. Based on this refined methane gas, hydrogen is manufactured in a reformer and transformer, and this hydrogen is supplied to the cell (cell stack).

Figure 10-4 Flow of Digestion Power Generation (Fuel Battery)



4) General Features

The general features of the fuel cell are as follows.

a) High efficiency
b) No noise or vibration because there are no rotating parts
c) Clean exhaust
d)

Water (H_2O) and carbon dioxide are generated during the reaction process; however, there is hardly any nitrogen oxide (NOx), which is a cause of air pollution. Moreover, since the overall efficiency of fuel cells is high, emissions of carbon dioxide (CO_2) are far smaller than in other forms of electricity and heat.

10.4 Prediction of Optimistic Digestion Gas Volume Generated in MWSS Jurisdiction Areas

10.4.1 Projection of Population in MWSS Service Area

Population in 2020 in MWSS service area is projected in MWSS Master Plan 2005 as follows.

NCR	12,077,301
Cavite	1,179,874
Total	13,257,175
Rizal	4,672,308
Grand Total	17,929,483

Maynilad has planned that their water supply population in 2021 is as follows.

NCR	8,302,484
Cavite	1,214,651
Total	9,517,135 (91%)
Parañaque and Las Piñas	
Parañaque	479,089 (100%)
Las Piñas	437,575 (98%)
Subtotal	916,664

1) Sewage Sludge Generation

Assuming that sewage sludge generation rate is 1% of wastewater generation, and sewage per-capita is 180l/d, potential sewage sludge generation in MWSS territory is calculated as follows.

Table 10-7 Potential Sewage Sludge Production in MWSS Territory in 2020

Area	Population	Potential Sludge Generation (m^3/d)
NCR	12,077,301	21,739
Cavite	1,179,874	2,124
Total	13,257,175	23,863
Rizal	4,672,308	8,411
Grand Total	17,929,483	32,273

Table 10-8 Potential Sewage Sludge Production in Maynilad Territory in 2021

Area	Population	Potential Sludge Generation (m^3/d)
NCR	8,302,484	14,944
Cavite	1,214,651	2,186
Total	9,517,135	17,131
Pranãque	479,089	862
Las Piñas	437,575	788
Subtotal	916,664	1,650

Calculations used for **Table 10-7** and **10-8** are done assuming that swage water per capita is 180l/d, and sludge generation rate is 1% of Influents flow rate.

2) Expected Sludge Gas Production and Electric Power Generation

Gas Production rate and Gas Power Generation rate shall be applied each pessimistic rate such as;

Daily Digesting Gas Production	0.06 x sewage influent rate (m^3/d)
Daily Gas Power Generation Rate	1.6 x digesting gas volume (kWh)

In MWSS territory, the following assumption in 2020 shall be used for the calculations, such as:

Water Supply Coverage	90%
Wastewater Effluent	80%
Sewerage Service Coverage	
NCR	60%
Cavite	30%
Rizal	20%

Table 10-9 Sludge Gas Production and Electric Power Generation in MWSS in 2020

Area	Gas Production (m^3/d)	Power Generation (MWh/d)
NCR	78,260	125
Cavite	3,823	6

Total	82,083	131
Rizal	10,093	16
Grand Total	92,176	147

In Maynilad territory, the following assumption in 2021 shall be used for the calculations, such as:

Water Supply Coverage 91%
Wastewater Effluent 80%
Sewerage Service Coverage
- NCR 60%
- Cavite 30%
- Parañaque 60%
- Las Piñas 60%

Table 10-10 Sludge Gas Production and Electric Power Generation in Maynilad

Area	Gas Production (m^3/d)	Power Generation (MWh/d)
NCR	53,798	86.10
Cavite	3,935	6.30
Total	57,733	92.40
Prañaque	3,103	5.00
Las Piñas	2,837	4.54
Subtotal	5,940	9.54

10.5 Effectiveness as Mitigation Measure against Climate Change by Sludge Digestion

At this moment (year 2010), total population in the project sites is about 1,140,000 and septage desludging service from domestic septic tanks by MWSI covers only 26% (300,000). Sewerage service is not in practical, and desludging interval of septic tanks is 6 to 7 years, thus septage itself has already digested in the septic tanks otherwise the septic sludge (septage) have discharged over to the street drainages or creeks before desludging the tanks. Overflowed domestic gray water or untreated discharged water accumulate sewage sludge partially in the street drainages, creeks, rivers or the other water receiving bodies, and remaining SS are reach at Manila Bay and discharged in the bay. Eventually accumulated sewage sludge are degraded in the waterways, and during the process, methane gas is emitted into the air from creeks, esteros, rivers, septic tanks and this methane gas emission contribute to the climate change.

Assuming wastewater generation per capita is 130 l/d, total wastewater generation in the project area would reach at as much as 148,000m^3/d and when 50% of the sewage sludge are degraded during the journey to the bay, everyday methane gas emission would be 3,000m^3/d or 2,140t/d (44,900tCO_{2e}/d), This means the project areas produce 25,640ktCO_{2e}/y. This fact expects the sewerage system project should be realized as soon as possible in the areas to mitigate climate change caused by sewerage sludge gas.

10.5.1 Total Reduction of Greenhouse Gas expected (Optimistic)

The methane gas produces in the process of sewage sludge digestion should be inflamed and/or used for the digestion gas power generation system, and consequently the methane gas is decomposed into CO_2 and H_2O. Since GWP_{CH4} is 21times GWP_{CO2}, this decomposition is effective for reduction of greenhouse gas effect by methane gas emitted during the course of CH_4 degradation.

The baseline emission and project emission of greenhouse gas are predicted by the following expression;

$BE_y = MB_y \cdot GWP_{CH4} + PO_{ENv}$
$PEy = MD_{reg.y} \cdot GWP_{CH4+} SPO_{EN.y +} PO_{ENv} - BE_{EN.y}$

GHG emission reduction rate per year (ER_y) is calculated by expression: ERy= BEy - $PE_{y,}$, thus;
$ER_y = (MB_y – MD_{reg.y}) \cdot GWP_{CH4} + BE_{EN.y} - SPO_{EN.y}$

Where:
BE_y: Baseline emission in year of y (ton CO_2 equivalent: tCO_2e)
PEy Project emission in year of y (ton CO_2 equivalent: tCO_2e)
MB_{y}. Generated methane gas volume in year of y（tCH_4）
$MD_{reg.y}$: Natural decomposition volume of methane gas in year of y (tCH_4)
GWP_{CH4}: Climate change Potential （$tCO_2e/tCH_4 = 21$）
$BE_{EN.y}$.: Electric power Substituted by methane gas power generation system in year of y（tCO_2e: 0.36tCO2/MWH by Federation of Electric Power Companies-FEPC in1999）
PO_{ENv} Power consumption for plant operation
$SPO_{EN.y}$ Power consumption for digesting system operation (0.014kt CO_2e/yr)

If 50% of the total methane gas production predicted in the sewage treatment plants in MWSS territory is decomposed by sewage sludge gas usage as bio-energy, the greenhouse gas reduction would be expected as follow.

Table 10-11 Reduction of Greenhouse Gas Effect (in MWSS: 2020)

Area	Methane gas generation (1,000t/yr)	Methane gas consumption				Total reduction of greenhouse gas (baseline emission) (1,000tCO_2e/yr)	
		CH4 consumed (1,000t/yr)	CO2 equivalent (1,000t/yr)	Gas Power Generation (Mwh/yr)	CO2 equivalent (1,000t/yr)	Inflamed	Plus gas power Generation
NCR	12.24	6.12	128.54	22,813	8.21	128.54	265.30
Cavite	0.60	0.30	6.28	1,095	0.39	6.28	12.95
Total	12.84	6.42	134.82	23.908	8.61	134.82	278.25
Rizal	1.58	0.79	16.58	2,920	1.05	16.58	34.21
Grand Total	14.42	7.21	151.40	26,828	9.66	151.40	312.46

Note: 1. Methane gas concentration is assumed 60%.
2. Because of daily treatment system of sewage sludge, $MD_{reg.}$ should be neglected.

Table 10-12 Reduction of Greenhouse Gas Effect (in Maynilad: 2021)

Area	Methane gas generation (1,000t/yr)	Methane gas consumption				Total reduction of greenhouse gas (baseline emission)		
		CH4 consumed	CO2 equivalent	Gas Power generation	CO2 equivalent	Inflamed	Gas power generation	In total
		(1,000t/yr)	(1,000t/yr)	(Mwh/yr)	(1,000t/yr)	(1,000tCO2e/yr)		
Pranãque	0.49	0.24	5.10	913.00	0.33	5.10	0.33	5.43
Las Piñas	0.44	0.22	4.66	829.00	0.30	4.66	0.30	4.96
Subtotal	0.93	0.46	9.76	1,742.00	0.63	9.76	0.63	10.39
NCR	8.42	4.21	88.36	15,713.00	5.66	88.36	5.66	94.02
Cavite	0.62	0.31	6.46	1,150.00	0.41	6.46	0.41	6.87
Total	9.97	4.98	104.58	33,726.00	12.17	104.58	12.14	116.72

Note: 1. Methane gas concentration is assumed 60%.
2. Because of daily treatment system of sewage sludge, $MD_{reg.y}$ should be neglected.

In case that bio-treatment process is adopted to the sewerage system, generation of the sewage sludge treatment could not be avoided in the sewerage systems. However, 100 % coverage by the sewerage treatment systems in Metro Manila would be difficult to realize, because of various reasons such as budgetary deficit, physical and geographical conditions, financial problems, low perception of the residents to environmental improvement, and so on. Thus, two concessionaires would cover sewerage and sanitation services in the non sewer service areas by desludging services of the septic tank systems.

If MWSS is developing sewerage treatment system to cover 50% of residents in their territory and sewage sludge digesting system in the plants is integrated in the systems, reduction of greenhouse effect would reach at 312.46x10^3 tCO_2e /year in year of 2020, and Maynilad would devotes 215.86x10^3 tCO_2.e/year in 2021 to the reduction effect. The role of digesting gas power generation system seems to be small in aspect of greenhouse gas effect reduction, but distribution to power consumption of sewerage system operation would be effective. The effect of the power reduction from the commercial power supply to the plant would reach at one third of total electric demand of the plant.

10.5.2 CDM Application of Sewerage Treatment System

Sewerage Treatment System contains principally of sewage treatment process, sewage sludge treatment process, sewage collection sewers, and sewage treatment system is essential to integrate into sewage treatment system. The sewage sludge digesting process is conventional and prevailingly adopted to much sewerage treatment systems in many countries. The main purpose of the process is to reduce total excess sludge volume, realize immunological security against virus or pathogenic bacteria, and digested sludge itself is very stable matters under appropriate conditions like dewatered or as acid soil, and shows sluggish turnover at least several decades. The digesting process is in anaerobic condition, thus in the process, sludge digestion gas is generated. The sewage sludge digesting gas containing around 60 to 65% methane gas, and methane gas is toxic, so the gas is stored in the gasholder after desulferizing process and then flared or used as gas power generator fuel. This treatment system eventually decomposes methane gas into innoxious CO_2 and H_2O. GOW of methane gas is 21 times CO_2, therefore this digestion process also dedicates as countermeasure against climate change.

The expected methane gas reduction generated in Parañaque and Las Piñas sewerage treatment systems could be 20KtCO_2e/year (refer **Table10-12**). The possibility of CDM application of the sewage sludge digesting process is studied herein under.

1) Kyoto Protocol

The Kyoto Protocol was adopted at the 3rd session of the Conference of the Parties (COP3) to the

United Nations Framework Convention on Climate Change (UNFCCC) held in Kyoto, Japan, in December 1997. The Protocol defines quantified greenhouse gas (GHG) emissions reduction targets for Annex I Parties. Annex I Parties means those listed in Annex I of the UNFCCC. They are developed countries including Economies in Transitions, e.g. Russia and Eastern Europe. Annex I Parties have different GHG emission ceilings for the 5-year period of 2008-2012 (1st commitment period). Emission ceiling which is called “assigned amounts” for each Party is calculated as follows.

The base-year emissions” x “emission reduction target” x five

The base-year emissions are basically a Party’s aggregate GHG emissions in 1990 (whereas, countries may use 1995 as its base year for HFCs, PFCs, and SF_6). GHGs defined by the Protocols are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFCs, PFCs, and SF_6.

The Protocol introduces 3 market mechanisms, namely the Kyoto Mechanisms. Annex I Parties would be able to achieve their emission reduction targets cost-effectively, by using these mechanisms, that is;

- Joint Implementation (JI)
- Clean Development Mechanism (CDM)
- International Emissions Trading

2) The Clean Development Mechanism (CDM)

In the basic mechanisms described above, CDM could be applied between Japan (and the other Annex I Parties) and Philippines, That is;

- Annex I Parties which have ceilings for GHG emissions (emission caps), assist non-Annex I Parties which don’t have emission caps, to implement project activities to reduce GHG emissions (or remove by sinks), and credits will be issued based on emission reductions (or removals by sinks) achieved by the project activities.

  - A Party where CDM project is implemented is called a host Party.
  - The credit from the CDM is called certified emission reduction (CER).
  - Reductions in emissions shall be additional to any that would occur in the absence of the certified project activity.

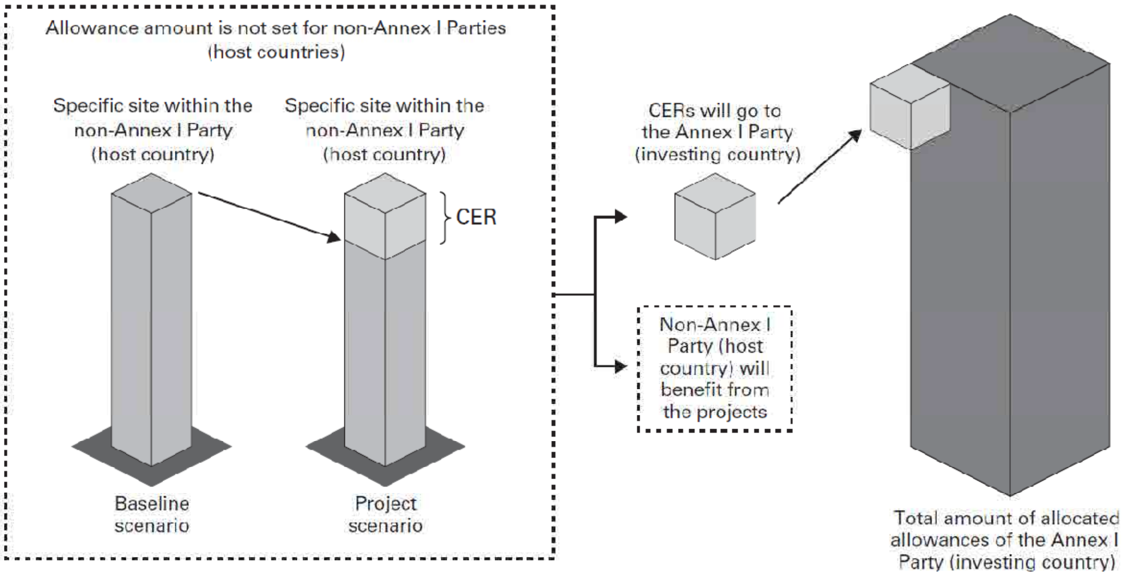
- Annex I Parties can use CERs to contribute to compliance of their quantified GHG emissions reduction targets of the Kyoto Protocol.

  - As a result, the amount of emission cap of Annex I Parties will increase.
- The CDM will issue CERs before the 1st commitment period.

  - CERs issued based on activities during the period from the year 2000 up to 2012 can be used in achieving compliance of Annex I Parties in the 1st commitment period.

The outline of the CDM is shown in **Figure 10-5**.

Figure 10-5 Outline of the CDM



(CDM/JI Manual 2010, Ministry of the Environment, Japan)

10.5.3 CDM in the Philippines

1) Current Status of CDM in the Philippines

According to IGES CDM Project Data Base, basic Information as of 31 March 2011is as follows;

CDM projects registered at CDM executive board	52 Projects
CDM projects at or after the validation stage	29 projects

The CDM project field of the above is shown in **Table 10-13.**

Table 10-13 Basic Data on CDM Projects (as of 31 March 2011)

(IGES CDM Project Database)

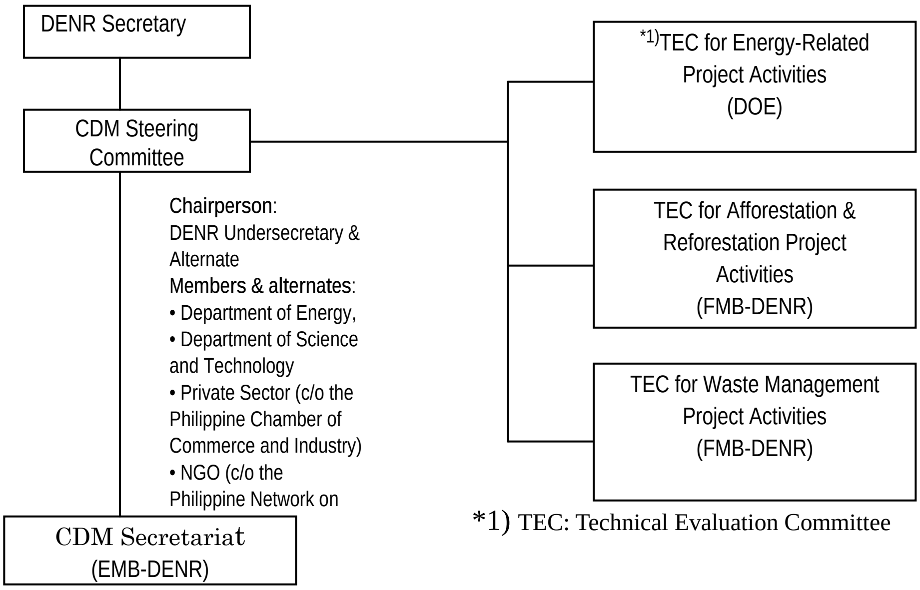
	Registered CDM Projects				Review Requested	Rejected
	No. of	Ave. Annual Ers	Total ERs by	Issued CERs		
Biogas (Animal waste)	33	9,649	900,568	5,637	4	1
Biogas (Waste water treatment)	2	62,313	657,731	0	1	0
Biomass Utilization	5	45,915	844,143	0	0	0
Cement	0	0	0	0	0	1
Geothermal power	1	74,976	368,713	0	0	0
Hydro power	3	44,161	389,381	0	0	0
Methane avoidance (Composting)	1	6,058	24,467	0	0	0
Methane recovery & utilization (Landfill)	3	288,919	2,952,812	154,194	3	0
Secondary catalytic reduction of N2O emission	1	39,203	111,272	0	0	0
Waste gas/heat utilization	1	36,757	329,317	15,637	0	0
Wind power	1	56,788	435,634	64,568	0	0
Total	52	36,969	7,014,036	240,036	8	2

2) CDM National Approval Process

CDM in the Philippines is managed by Designated National Authority (DNA). The structure of DNA is shown in Figure 10-5.

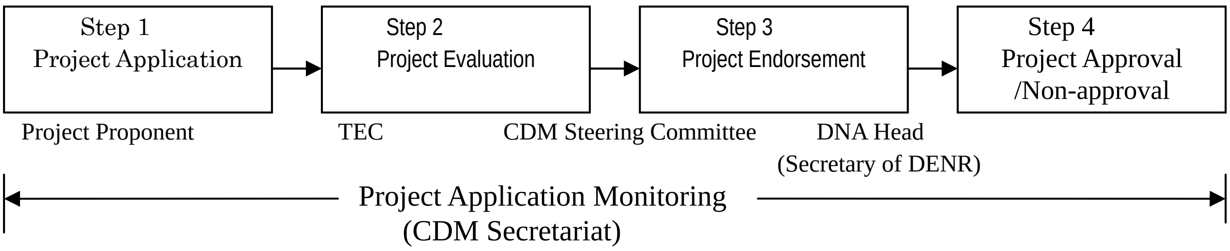
Figure 10-6 DNA Structure

(DENR Administrative Order No. 2005-17_Aug 31, 2005)



CDM national approval process basic steps is shown in **Figure. 10-7.**

Figure 10-7 DNA Approval Procedure



3) Decrees designating the Philippine DNA for CDM
Designations of the Philippines DNA for CDM are shown in **Table 10-14**

Table 10-14 Designation of the Philippine DNA for CDM

Decrees	Issuance
Executive Order No. 320, series of 2004: Designating the Department of Environment and Natural Resources (DENR) as the National Authority for the Clean Development Mechanism	2004/6/25
Promulgation of the Rules and Regulations Governing the Implementation of Executive Order No. 320, series of 2004	2005/8/31 (Signature) 2005/9/7 (Effectivity)

Table 10-15 and **16** show the "CDM application fees and processing time" and "DNA Approval Criteria respectively.

Table 10-15 Application Fees and Processing Time

	Fees (Peso)	Target Time (Working Days)
Filing Fees 600	600	
CDM Project Activities Not Considered Small Scale	10,000	15-20
Small-Scale CDM Project Activities	5,000	20-25

Table 10-16 DNA Approval Criteria

Economic Dimension	
Criteria	Project Level Indicators (Examples)
Provide livelihood and other economic opportunities in the community	Local companies to be contracted for the construction, implementation.
	Number of workers from the host community (skilled and unskilled, contractual and permanent employment, competitive packages).
	Livelihood opportunities.
	Finance schemes for sustainable alternative livelihood.
Provide proper safety nets and compensatory measures for affected stakeholders	Measures to address the replacement of lost assets, loss of livelihood opportunities as a result of the project.
	Safety nets and compensatory measures as a result of operation/implementation risks and potential hazards.
Provide new financial resources	Transfer of appropriate technology (describe actual technology, extent of its application in the sector, dependability/reliability/efficiency and expected technological problems and how to address such problems).
	In addition to the estimated foreign capital inflow received from an Annex I country and the reduction in expenditures for a particular item as a result of the project, include the amount of savings to be generated and the amount of funds therefrom to be allocated for other purposes for the improvement of the host community such as setting up of development funds for sustainable programs for disadvantaged sectors / groups, employee benefits, etc.
Social Dimension	
Provide education and training which build the capacities of local stakeholders	Frequency and types of training (social, technological, entrepreneurial, etc.) for the project's labor force and the host communities.
	Frequency of educational tours for academe, related industries and other interested parties on the technology,impacts of climate change and CDM – visits/tours/lectures conducted per month.
	Scholarships for deserving local stakeholders.
Provide vulnerable groups access to local resources and services	Access to local resources (fishing grounds, forests, water, etc.).
	Supply of and access to basic needs (water, food, electricity, medical outreach, etc) for affected vulnerable groups.
Promote local participation in the project activity	Level of coordination with and participation of various sectors, social development strategies, integration with the community.
Environmnetal Domension	
Improve local environmental quality	Measurable indicators to show the improvement in local environmental quality other than the GHG emission reduction – schedule of surveys, inventories and other monitoring tools.
	Stability and treatment of any form of waste coming from the project.
Comply with environmental policies and standards	Present and expected level of compliance with all applicable environmental policies and standards (EIA, air, water, land use and forestry, natural habitat and protected areas, waste hazardous, etc.) vis-à-vis historical data.
Promote sustainable use of natural resources	Concrete efforts of the project to promote sustainable strategies and programs for the use of natural resources in and around project site (water, forests, etc.).

Source: Joyceline A. Goco (2006) "Host Country Approval Process: Initial Experiences" (presentation)

10.5.4 Possibility of CDM Application of the Project Components

As described in Section 10.5.2, Sewage sludge digesting process shall be incorporated into the sewerage treatment system; therefore this process itself shall be constructed without CDM project. Principal objectives of integration of digesting process in the sewage sludge treatment system are;

- Reduction of sewage sludge volume (40 % reduction in weight after digested, and
- Disinfection and stabilization of sludge cakes in the field.

Sewage sludge emits methane gas in the process of its degradation in natural atmosphere. Therefore if the methane gas reduction scheme is added into the existing or planned sewage sludge treatment process that does not integrate any methane reduction process in it, there is possibility to apply CDM to the project components.

1) Approved Baseline

Regarding sewerage treatment systems, methane gas that is emitted during the sludge natural degradation process is principal GHG. Therefore application of CDM to sewerage system is mainly to the baseline scenarios emitting methane gas in atmosphere from the sewerage treatment systems. **Table 10-17** shows approved baselines for CDM and it also evaluate the applicability to this project.

This project is to establish new sewerage systems in the propjet areas, and as such the six scenarios shown in the table are not applied to.

2) Applicable CDM Application to the Project

The alternatives of the sludge treatment systems in the project are reviewed and studied its possibility for CDM as follows.

a) Raw sludge dewatering

Direct sludge dewatering entails using filtration (including open-air drying bed) or centrifugal equipment to forcibly dewater and turn wet sludge into sludge cake. Accordingly, since there is no methane generation process involved, there is no capture of methane, however, after dumping them into dumping site, or reclaimed, degrading is developing and methane gas is emitted into the air out of bound. Thus this method could not be alternative.

b) Sludge drying

Sludge drying entails using direct heating-based drying or indirect heating-based drying equipment to dry sludge with a view to adjusting water content geared to effective use as well as saving energy and achieving stabilization in incineration and melting. From the drying equipment, since large amounts of odorous, hazardous and combustible gases such as ammonia and hydrogen sulfide are generated, it is necessary to conduct proper treatment. Moreover, in the sludge drying method, since there is no methane fermentation process involved, no methane is generated only in the process, and by the same reason, it cannot be alternated.

Table 10-17 Approved Baselines related to Sewerage System

Methodology		Typical Project	Baseline Scenario	Project Scenario	Application to This Project
AM0025	Avoided emissions from organic waste through alternative waste treatment processes	The project involves one of a combination of the following waste treatment options: composting process in aerobic conditions; or gasification to produce syngas and its use; or anaerobic digestion with biogas collection and flaring and/or its use (this include processing and upgrading biogas and then distribution of it via a natural gas distribution grid); or mechanical/thermal treatment process to produce refuse-derived fuel (RDF)/stabilized biomass (SB) and its use; or incineration of fresh waste for energy generation, electricity and/or heat.	Disposal of the waste in a landfill site without capturing landfill gas or with partly capturing and subsequently flaring it.	Alternative waste treatment process. Such processes could be composting, gasification, anaerobic digestion with biogas collection and flaring and/or its use, mechanical/thermal treatment process to produce RDF or SB and its use, or incineration of fresh waste for energy generation	Negative: Sewage sludge will be treated in the plant site, and dewatered sludge cake is already stable.
AM0039	Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting	The methodology is applicable to projects that avoid CH_4 emissions resulting from anaerobic degradation of the organic wastewater in open lagoons or storage tanks or from natural decay of bioorganic solid waster in landfills (not from manure management).	Land filling of the bioorganic solid waste and wastewater treatment in an existing or new to be built anaerobic lagoon or open tanks results in CH_4 emissions.	Co-composting for treatment of the organic wastewater and the organic waste. CH_4 emissions due to anaerobic decay are avoided.	Negative: Wastewater treatment is of aerobic process, and solid waste is not treated by MWSI.
AM0080	Mitigation of greenhouse gases emissions with treatment of wastewater in aerobic wastewater treatment plants	Implementing a new aerobic wastewater treatment plant for the treatment of domestic and/or industrial wastewater, with sludge treated either in the same manner as the baseline, or in a new anaerobic digester with biogas capture. The biogas is either flared and/or used to generate electricity and/or heat.	Wastewater would have been treated in anaerobic open lagoon system without methane recovery and flaring. Sludge would have been dumped or left to decay, or dried under controlled and aerobic conditions and then disposed to a landfill with methane recovery or used in soil application.	Installation of a new aerobic wastewater treatment plant. Sludge is treated either the same way as the baseline or in a new anaerobic digester with the biogas capture.	Negative: Wastewater in the project area is not treated by anaerobic open lagoon, or any other wastewater treatment system.
ACM0014	Mitigation of greenhouse gas emissions from treatment of industrial wastewater	Treatment of industrial wastewater in a new anaerobic digester, capture and flaring or utilizing of the generated biogas for electricity or heat generation; or treatment of industrial wastewater in the same treatment plant as in the baseline situation but treatment of the sludge from primary and/or secondary settler either in a new anaerobic digester or treatment of sludge under clearly aerobic conditions.	Existing wastewater treatment system results in release of methane into the atmosphere.	Capture of methane in the wastewater treatment system results in less GHG emissions. In case of energetic use of GHG-intensive energy generation.	Negative: Targeted waste water is domestic.
AMS-Ⅲ.H	Methane recovery in wastewater treatment	Recovery of biogas resulting from anaerobic decay of organic matter in wastewaters through introduction of anaerobic treatment system for wastewater and/or sludge treatment	Methane from the decay of organic matter in wastewater or sludge is being emitted into the atmosphere.	Methane is recovered and destroyed due to the introduction of new or modification of existing wastewater or sludge treatment system. In case of energetic use of biogas, displacement of more- GHG-intensive energy generation.	Negative: The recommended wastewater treatment system is of aerobic process to capture the sewage sludge in short time without any retention for the sludge to decay in the plant.
AMS-Ⅲ.I	Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems	Avoidance of production of methane from organic matter in wastewater being treated in anaerobic systems. Due to the project, the anaerobic systems (without methane recovery) are substituted by aerobic biological systems	Organic matter in wastewaters is being treated in anaerobic systems and produced methane is being released into the atmosphere	Anaerobic wastewater treatment systems, without methane recovery, are substituted by aerobic treatment systems.	Negative: The wastewater treatment system is aerobic of process.

c) Composting

Composting entails decomposing soluble organic matters in sewage sludge by means of microorganisms in an aerobic environment, and stabilizing the sludge into a form and state that can be utilized on green farmland. Aerobic microorganisms reduce the molecular weight of part of the organic matter in a habitable environment, eventually breaking it down into carbon gas, ammonia, water and inorganic salts. Accordingly, exhaust gases that contain odorous contents are generated, however, since there is no methane fermentation process involved, no methane is generated, but stand-by period in the storage of the compost is long, degrading of the stand-by period methane gas would be emitted. The compost plant requires wide space for construction and is kind of hazardous plant to residents because of strong offensive odor, so it cannot be constructed in the candidate sites.

d) Sludge incineration

Sludge incineration entails incinerating dewatered sludge under atmospheric pressure while feeding more air than the theoretically required air flow for incineration, until only inorganic ash remains. When designing incinerators, it is necessary to achieve a structure that enables efficient operation so that emissions of nitrous oxide (N_2O) are reduced and NO_X is not increased with a view to mitigating greenhouse gases. Since the exhaust gases discharged from the incinerator include sulfur oxides, particulates, nitrogen oxides and hydrogen sulfide, etc., it is necessary to install an exhaust gas treatment unit. Incidentally, it is not necessary to install deodorization equipment in the case of fluidized incinerators because odorous substances are broken down by the heat. Moreover, in sludge incineration equipment, since there is no methane fermentation process involved, no methane is generated. Because of large energy consumption and big capital cost and maintenance cost, it is economically unfeasible.

e) Sludge melting

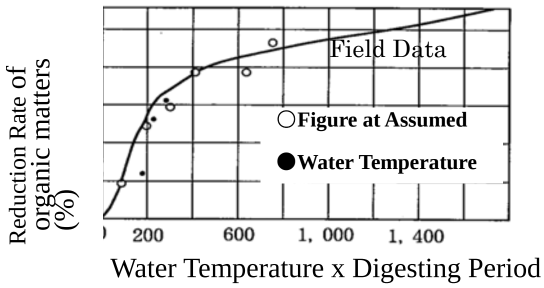
Sludge melting entails utilizing various types of melting equipment to melt the sludge with a view to further reducing volume, stabilizing and recycling the sludge compared to the incineration process. In the same way as sludge incineration, since the exhaust gases discharged from the incinerator include sulfur oxides, particulates, nitrogen oxides and hydrogen sulfide, etc., it is necessary to install an exhaust gas treatment unit. Moreover, in sludge melting equipment, since there is no methane fermentation process involved, no methane is generated. But at this moment, this process is only constructed as a pilot plant, and products for construction has many problems to be resolved, such as it cannot realize stable supply or enough quantity to the contractor request, etc.

f) Aerobic Digestion:

This method entails using respiratory aerobic microbes to break down high-concentration organic matter into carbon dioxide and water, and it generally doesn’t generate methane.

The organic matter reduction rate in this method is 20~40%. As is shown in the following diagram, the organic matter reduction rate is related to the water temperature (sludge temperature: ℃) x digestion period (days), and since an inflection point appears at a reduction rate of 38% at 400℃/day. According to the diagram, if the level is set at 1,800℃/day or higher (sludge temperature 20℃, digestion time 90 days, ventilation flow 3,600 m^3/digestion tank), an organic matter reduction effect equivalent to that attained in anaerobic digestion can be realized

Figure 10-8 Relation of Organic Matter Reduction Rate (per water temperature x digesting period)

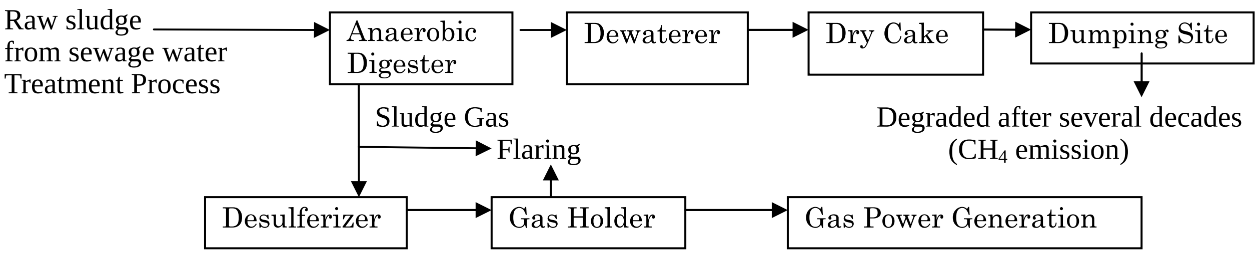


(1) Possible Alternatives of the Project Plan

The sewage sludge treatment process is essential for the sewage treatment system. The project would construct sewage sludge treatment plant in corporate with sewage water treatment process. And digesting process is the important part of the plant because of the reasons mentioned above. Thus this plant shall be constructed without CDM project.

Process flow of the sewage sludge treatment system to be applied is shown hereunder.

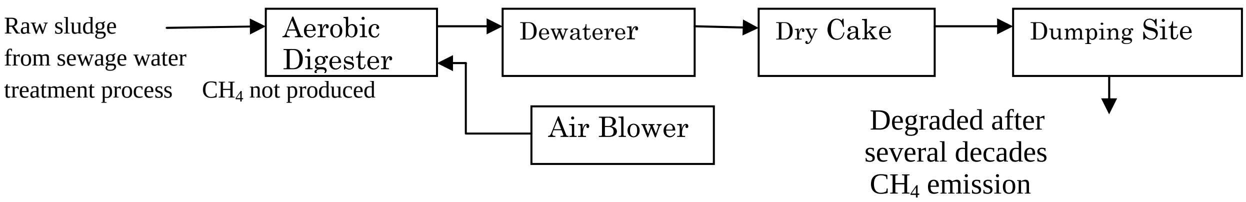
Figure 10-9 Sewage Treatment Process in the Sewerage Treatment Plant (Base Line Scenario)



The sewage sludge conveyed from sewage water treatment process is digested in the digesting tank for about 30 days. The digested sludge is dewatered at the next stage to produce dry cake with water concentration rate about 85% and dumped or used as soil development. Dumped dry cake is very stable, but after several decades degrading gradually occurs and in the process methane gas emitted. About 60% of sludge is digested and decomposed into digestion gas and water. The digestion gas contains 60 to 65 methane gas, and the methane gas is flared or used as fuel of gas power generation.

The only alternative for this system is aerobic digesting process, which will not produce methane gas in the process. Figure 10-8 shows the aerobic sludge digestion system.

Figure 10-10 Alternative Project (Project Scenario)



The organic matter reduction rate in this method is ordinarily 20~40%, and No methane gas is produced in the process. In order to select this method as an alternative for anaerobic process, the organic matter reduction rate should increase at least up to 60%.

The cost for this is studied hereunder.

Thickened sludge produced in the project areas when sewerage system covers 100 % over the areas, thickened sludge production rate is around 1300m^3/d. The followings are estimates of aerobic process capacity and necessary aeration volume.

a) Calculation of Necessary Facilities

Thickened sludge influent：1300m^3/ d
Size of aerobic tank：Sludge volume x Digesting days＝1300×90＝117,000m^3
Digesting Period：90days
Tank sizes：W10.0m×L30.0m×D5.0m×78tanks
Digesting Capacity：10.0×30.0×5.0×78＝117,000m^3
Air volume required：Tank Capacity×Aeration Volume＝
117,000m^3×40m^3/m^3・ d ＝4680000m^3/ d ＝3,250.00m^3/min
Blowing Air Volume：20～40m^3/Tank Capacity (m^3). d
Blowers Required
Type：Multi-step turbo blower
Diameter：φ500mm/φ450mm
Sucking Air Volume：300m^3/min
Output Pressure：5800mmAq
Motor Capacity：280kw
Quantity：12sets（including one stand-by)）

a) Calculation of Motor Output Power (Apply JS Standards）

(a) Conditions
Sucking Air（Q）：300m^3/min（20□、Atmosphere、65％RH）
(b) Sucking Pressure P1g：－200mmAq
(c) Output Pressure P2g：5,800mmAq（from Tank Depth）
(d) Absolute Sucking Pressure P1
P1=P0＋P1g mmAq abs=10,333－200＝10,133 mmAq abs
P0：Atmosphere＝10,333 mmAq abs
(e) Absolute Output Pressure P2
P2=P0＋P2g mmAq abs=10,333＋5,800＝16,333 mmAq abs
(f) Blower Sucking Air Volume Q1（m^3/min）
Q1＝Q×（P0/P）＝300×（10,333/10,133）＝306m3/min
(g) Blower Insulation Heat Power L1（kw）

$$L1=\frac{Q1\times P1}{6{,}120 \text{ x } \frac{K\text{-}1}{K}}\left\{\left(\frac{P2}{P1}-1\right)^{(k\text{-}1/k)}\right\}$$

k -1/ k ：Coefficient 0.286

$$L1=\frac{306\times 10{,}133}{6{,}120\times 0.286}\times\{(16{,}133/10133)^{0.286}-1\}=252\text{kw}$$

(h) Required Power L2（kw）

L2＝（L1／ηtan）＝252/0.76＝332kw

Htan：Total Heat Insulation Effect76％

(i)Power at Minimum Temperature（ｔ1'□） L2' kw

L2'＝ｌ2×（(273+20)／(273+ｔ1')）＝252kw

Where

Minimum temperature：20□

(j) Motor Output PowerL0kw

L0＝L2'×（1+α）＝252×（1+0.05）＝264.6kw＝280kw

The followings show the cost estimate of construction of aeration and defusing system for aerobic digestion system with JS unit price.

Table 10-18 Additional Cost for Aerobic Digestion Alternative

Facility	Specification	Set	Quantity	Unit Price	Cost in Php
Mechanical					
Turbo Blower	300ｍ3/min	set	12	34,076,000	408,912,000
Motor	280kw 3	set	12	7,400,000	88,800,000
Air Filter	Dry type700ｍ^3/min	pc	5	675,000	3,375,000
Defuser	Pipe	pc	78	6,552,000	511,056,000
Sub-total	Mechanical cost				1,012,143,000
Piping, etc.	80% of the above				809,714,400
Designing					1,821,857,400
Electrical	40% of Mechanical				728,742,960
Operation Cost for 10 Years					2,091,084,600
Total					4,641,684,960
Operatin Management Fee					
Total Motor Output	280kw×11sets＝			3,080	kw
Operation Rate				0.7	
Electric Fee				10	peso/kwh
Electric Fee/yr	3080×0.7×24×365×10			188,865,600	peso/yr
Yearly Maintenance cost	2% of Facility cost				
	1012143000×0.02＝			20,242,860	peso/yr
Operation Management Fee/yr	188865600+20242860			209,108,460	peso/yr
Operatin Cost for 10 years	209108460×10＝			2,091,084,600	peso/10yrs
(CDM Max Period)					

This calculation means that it is uneconomical to set the reduction rate at around 40% or higher. And furthermore, this alternative feature of non gas production in the aerobic digestion process means loosing of business opportunity to get benefit as investigation. As mentioned above, the project component has long history and is used widely in the world, and this project component will be constructed without CDM project, and construction itself has no barrier for its implementation. As such, the project itself has nothing to against mandatory laws or regulations, and any CDM alternative deems difficult to be realized because of not additional.

Figure 10-11 Methodological Tool "Tool for the demonstration and assessment of additionality" (Version 05.2)

(UNFCCC/CCNUCC)

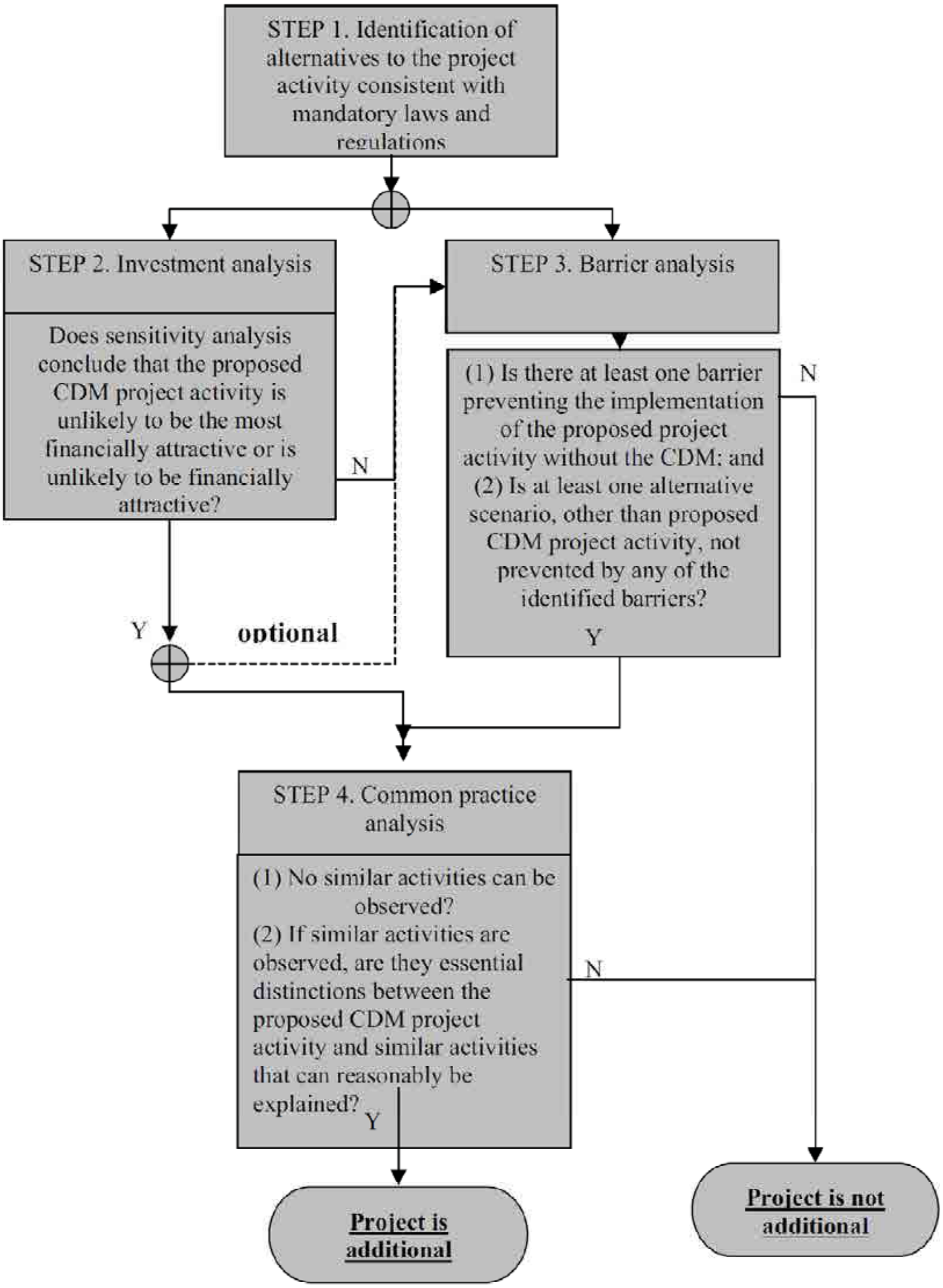
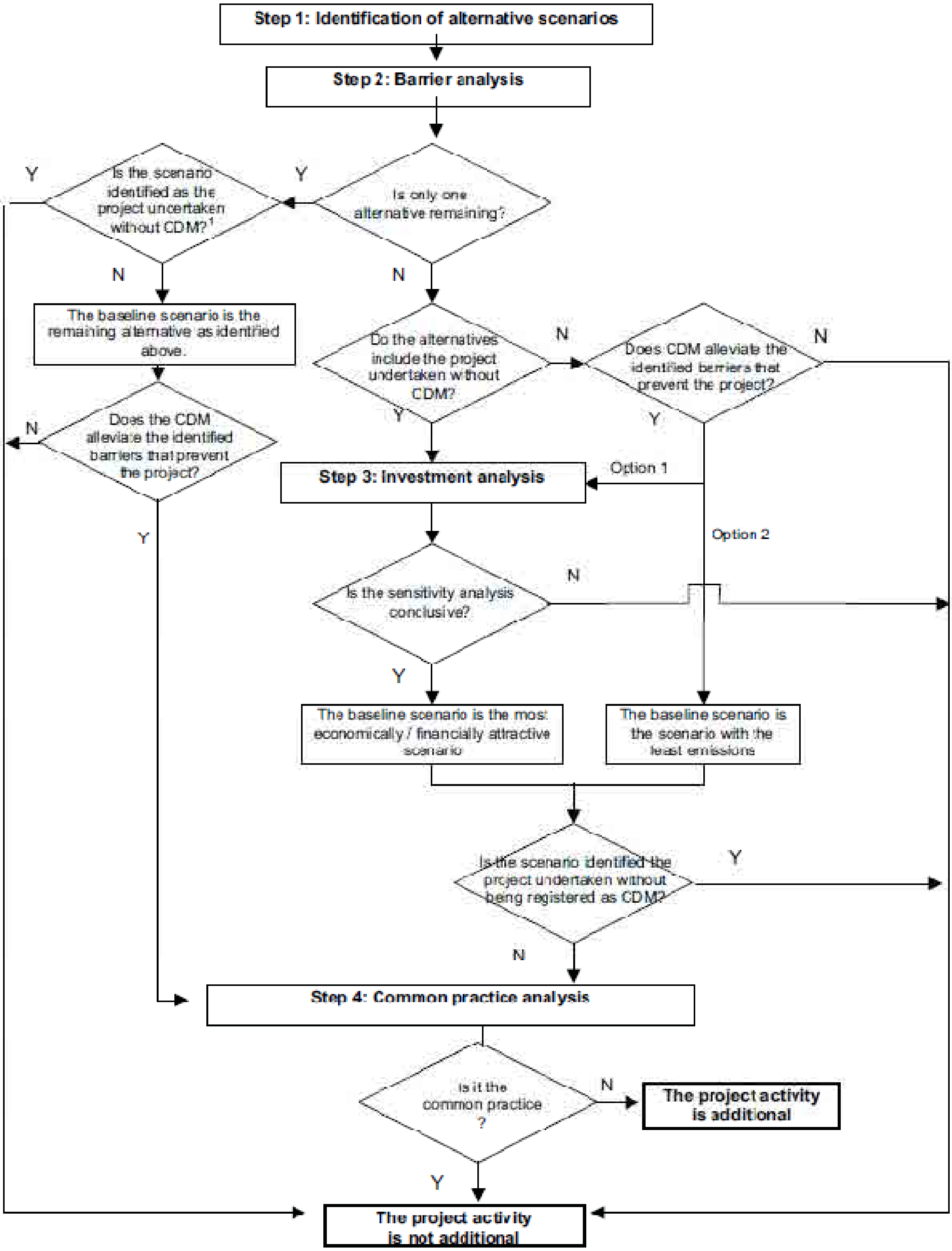


Figure 10-12 Combined tool to identify the baseline scenario and demonstrate additionality"

(Version 02)

(UNFCCC/CCNUCC)



3) Possibility of CDM Project in Phasing Construction Schedule

The implementation schedule of the project construction is recommended to take 4 phases. The phasing construction schedule is as follows;

Phase 1 from 2013 to 2016
Phase 2 from 2017 to 2020
Phase 3 from 2021 to 2024
Phase 4 from 2025 to 2028

34% of total construction schedule will be achieved in the first phase. If the first stage construction include only sewage sludge dewatering process without sludge digesting process, the sludge digesting process could be separated from the main construction, and the sewage sludge generation would commence after phase 1 plant commissioning, that is from year 2017. Sludge digesting process would require one year and half construction periods from the construction commencement year, thus if the process construction starts from year 2015, the process could be joined to the phase 1 sewage treatment plant (STP).

In the case, base line scenario is STP without sludge digesting process, and project scenario is to add the sludge digesting process. The application process time for CDM to issue CER would be predicted as follows.

Start application form	April 2012
Start comment until request registration	0.9 year
Request registration to registration	0.4 year
CER issuance from completion of registration	1.2 years

(Assumed with UNFCCC, UNEP Pipeline, Kyoto mechanism platform 2010)

According to the above assumption, CER issuance would be after August 2014. Therefore the sludge digesting process could be integrated in the STP main construction schedule.

(1) Additional Cost of the Digesting Process

The cost estimate of the process is as follows (x 1,000 Pesos)

• Civil Work of Digesting Tanks (6 tanks ϕ 24m, 12.5m depth)	357,762
• Miscellaneous construction cost	439,392
• Mechanical works	1,105,500
• Electrical works	442,200
• Total sum (x 1,000 Pesos)	2,344,857

(2) Credit Rate to be recovered

The GHG reduction rate is predicted about 20KtCO_2e/yr in Parañaque and Las Piñas. In case that this capital cost is covered by the credit in 10 years, the credit rate would be;

2,344,857/(10 x 20) = 11,724 Peso/ton

(Excluding operation cost of 1 % of the capital cost).

(3) Barrier against CDM Possibility

As described in Section 10.5.3, the sludge digestion process should be constructed in order to;

- reduce sewage sludge volume (40 % reduction in weight after digested, and
- disinfect and stabilize sludge cakes in the field

Thus, the process should be completed to integrate into the STP during STP construction period. And final GHG reduction rate of 20KtCO_2e/yr is planned to achieve after 2028.

The barrier or risks of the CDM possibility are deemed as follows;

- difficult to construct the system in parallel with STP construction,
- difficult to identify the responsibility for the plant overall function,
- not assure of CER to be issued before or within 2014, otherwise the digesting process should be implemented apart from CDM,
- final completion of the sewerage system is 2028, 15 years passed from commencement of the construction,
- credit rate is assumed more than 11,000 pesos per ton, which exceeds the political rate of 5,000 pesos in Tokyo, and
- STP construction will be ordered through an international bid, and it is difficult for the winner to be the CDM proponent.

4) Conclusion

As a conclusion, CDM possibility of the sludge digesting system is deemed difficult to be realized mainly by the reasons described hereunder.

(1) There is a possibility for Philippine Government to approve the project scenario, and it would take around one month for their approval process. However, there is no baseline approved and registered project scenario by UN related to this project scenario, and the application process time for CDM to issue CER would take 2.5 years to CER issuance from the registration.

(2) The project will start from 2012 and the sludge digesting process should be implemented together with sewage treatment process. Because the sludge digestion process is essential part of the plant, thus this process construction should be implemented together with the main sewage water process, which would not allow any suspension time to get CER issuance.

(3) The cost of the digesting process is estimated as much as 2,345 million pesos, which is deemed not to realize CDM because of out of business justification, eventually no proponent would be found.

(4) Maynilad (implementation agency) is in a hurry to establish the sewerage system in the project area in order to comply with Clean Act 2004, therefore they would not like to separate the sludge digesting process from main plant construction as CDM project.

11. CAPACITY BUILDINGS

This Section discusses the institutional study covering operation and maintenance system for the facilities and a training and education program to support the sewerage and sanitation improvement project. The institutional study of MWSS and MWSI/MWCI examined the present organization and proposed organization enhancement that stresses asset management and business plan management. The training plans for MWSS staff and that of the MWSI/MWCI are presented.

11.1 Institutional Study

An appropriate plan for organizational improvement shall be proposed upon taking into consideration the current conditions of MWSI/MWCI, future sewage system plans, organization of the operation management departments, staffing arrangements and the following items.

11.1.1 Operation and Maintenance System

1) Establishment and utilization of sewage system ledgers

(1) Contents of sewage system ledgers

Ledgers not only act as basic data for conducting the technical maintenance of facilities, but also they are useful for collecting and providing information needed for responding to accident reports from the public, holding discussions with other operators and responding to disaster situations, etc.

Accordingly, the preparation of sewage system ledgers is essential for conducting the maintenance of sewage systems. It is thus necessary to prepare ledgers that are easy to use without deviating from the objective and by adopting methods that are rational and appropriate. Whenever revisions or rebuilding, etc. occur in sewage system facilities, it is necessary to immediately amend ledgers so that they always reflect the latest conditions and respond to all sorts of needs. It is desirable to build electronic databases out of ledgers so that the contents can be searched and corrected and fully utilized according to the diverse needs of numerous users including ordinary residents, related government agencies, corporate officers and so on.

Through systematically surveying and inspecting the condition of facilities, establishing the techniques and order of priority of necessary cleaning and repairs based on findings, and efficiently implementing countermeasures, it is important to conduct planned maintenance geared to preventing accidents from occurring and extending the service life of facilities. For this reason, it is effective to compile maintenance ledgers that detail histories of cleaning, repairs and accidents, etc. Another facet of preventive maintenance is to take advance measures and increase the frequency of inspections concerning vulnerable areas based on information from past accidents and reports, etc. Since accidents such as road subsidence and so on are expected to become more frequent as more time passes after commissioning, it is desirable from the viewpoint of accident prevention to start organizing and analyzing accident history information as early as possible.

Sewage system ledgers should comprise investigation records, drawings and other supplementary documents, and they should be prepared with attention paid to the following items:

- Take care to prepare drawings from the construction stage so that completion drawings can be converted to facilities floor plans, thereby making preparation work easier.
- In addition to general drawings, it is desirable to prepare mesh index maps and align them to facilities floor plans (completion drawings).
- Prepare general drawings for the entire sewage system area upon using street plans (base maps) based on city plans.
- Prepare supplementary related documents.
- Prepare longitudinal sections and manhole detailed drawings. Also, facilities floor plans can be made easier to use if the years of installation, types and basic shapes of pipes are displayed.

- Organize investigative reports on computer according to combined flow, sanitary sewage or storm water facilities, treatment district or drainage district, type of pipe, diameter of pipe and occupied location, etc. By doing this, it is possible to aggregate assets, etc.
- Color-code combined flow, sanitary sewage or storm water facilities on drawings, enter installation years and works numbers, and link drawings with completion drawings. By doing this, it is possible to immediately obtain information when detailed drawings are needed.
- Align information on pumping stations and treatment plants with information on conduits, and specify remaining unnecessary pipes as existing pipe information.
- Prepare at least two copies of drawings and keep one in a separate location to guard against burning or loss in the event of fires or disasters. For this reason, it is desirable to convert sewage system ledgers into electronic data so that archiving is complete and simple.
- In cases where sewage system facilities are altered or undergo rebuilding, it is necessary to determine responsible staff and build a management setup to ensure that contents are appropriately reflected in ledgers.

In future it is forecast that more and more documents will be electronically supplied based on CALS, etc., and it is desirable that ledgers be converted to electronic information by utilizing this.

(2) Preparation of sewage system ledgers

Prepare the following types of investigative report as a minimum. Moreover, specify pipe types, installation years and other maintenance items according to necessity.

- General investigative reports: T**able 11-1-1** shows the typical format of a general investigative report.
- Investigative report on sewer lengths, conduit lengths, manholes and inlets
  Sewer length investigative reports: **Table 11-1-2** shows the typical format of a sewer length investigative report.
  Manhole and inlet investigative reports: **Table 11-1-3** shows the typical format of a manhole and inlet investigative report.
- Investigative report on pumping facility location, site area, structure and capability: **Table 11-1-4** shows the typical format of an investigative report on pumping facility location, site area, structure and capability.
- Investigative reports on treatment facility location, site area, structure and capability
  Investigative report on treatment facility location and site area: **Table 11-1-5** shows the typical format of an investigative report on treatment facility location and site area
  Investigative report on treatment facility structure and capability: **Table 11-1-6** shows the typical format of an investigative report on treatment facility structure and capability.
- Major equipment history ledgers
  When conducting maintenance of equipment, it is important to prepare and manage equipment ledgers concerning main items of equipment. **Table 11-1-7** shows the typical format of a major equipment ledger.

This ledger is like the medical record for major equipment. Its contents should be utilized as data for conducting fixed assets management and making decisions for future rebuilding.

Table 11-1-1 Typical Format of the General Investigative Report

Name of drainage or treatment district	

	Drainage district				Treatment district					Quantity of facilities									
Installed year	Notification No. and date of start of service	Area (ha)	Population	District name	Notification No. and date of start of service	Area	Population	District name	Start and completion dates	Section length (m)	Sewer length (m)	Manholes	House inlets	Street inlets	Pumping stations	Treatment plant Date of start of operation	Outfall position	Discharge destination	Remarks

Note: Enter the applicable facilities floor plan drawing number in the remarks column.

Table 11-1-2 Typical Format of the Sewer Length Investigative Report

Name of drainage or treatment district	

Installed year	Covered conduit (m)										Open conduit (m)			Grant total (m)	Remarks
	mm ○ 250	mm ○ 300		mm ○ 1800		Subtotal	mm □ W 2000 H 2000		Subtotal	Total	mm ⊔ W 3000 H 2000		Subtotal		

Note: Enter the applicable facilities floor plan drawing number in the remarks column.

Table 11-1-3 Typical Format of the Manhole and Inlet Investigative Report

Name of drainage or treatment district	

Installed year	Manholes						Inlets									Remarks
							House inlets				Street inlets					
	No. 1 Inner diameter (cm)		Horseshoe Service	Storm overflow chamber	Invrted siphon chamber	Subtotal	Inner diameter (cm)		Special	Subtotal	Inner diameter (cm)		Special	Subtotal	Grand total	

Note: Enter the applicable facilities floor plan drawing number in the remarks column.

Table 11-1-4 Typical Format of the Pumping Facility Location, Site Area, Structure and Capacity Investigative Report

Name	Location	Site area	Date of start of operation	Catchment area		Design population	Pumping capacity			Discharge destination	Landscaping facilities, etc.	Remarks
				Sanitary sewage	Rainwater		Sewage during fine weather	Sewage during rainy	Rainwater			
		m^2		ha	ha	People	m^3/minute	m^3/minute	m^3/minute		m^2	

Pumpng station location map 1/○○

Type		Unit	Quantity	Structure or model	Dimensions	Capability or capacity	Date of completion	Remarks
Inlet sewer		m				m 3/sec		
Gate chamber		Chamber						
Gate		Unit						
Grit chamber		Pond				m^2		
Screen		Unit						
Pump	Sewage pump	Unit				m^3/min		
	Rainwater pump	Unit				m 3/sec		
Discharge sewer		m				m 3/ecs		
Discharge gate		Unit						
Administration block		Block				㎡		

Note: 1. If pumping capability differs from the overall plan, specify the overall plan in brackets ().

2. If there are any facilities not specified in the type column, add appropriately.

3. Enter the equipment manufacturer, etc. in the remarks column.

Table 11-1-5 Typical Format of the Treatment Facility Location and Site Area Investigative Report

Name	Location	Site area	Date of start of operation	Design treatment area and treatment flow			Discharge destination	Landscaping facilities, etc.	Remarks
				Treatment area	Treatment flow during fine	Treatment flow during rainy			
		㎡		ha	m^3/day	m^3/day		㎡	
				Current treatment area and treatment flow					
				Treatment area	Treatment flow during fine	Treatment flow during rainy			
				ha	m3/day	m3/day			

Treatment plant location map 1/○○

Table 11-1-6 Typical Format of the Treatment Facility Structure and Capability Investigative Report

Name		Structure or model	Dimensions	Capability or capacity	Quantity	Date of completion	Date of start of operation	Remarks
Water treatment facilities	Inlet sewer			m^3/s	m			
	Grit chamber			m^3	unit(s)			
	Pump chamber			m^2	unit(s)			
	Sewage pump			m^3/min	unit(s)			
	Backup reaction tank			m^3	unit(s)			Moving diffuser
	Initial sedimentation tank			m^3	unit(s)			
	Reaction tank			m^3	unit(s)			Diffuser plate
	Blower			m^3/min	unit(s)			
	Final sedimentation tank			m^3	unit(s)			
	Disinfecting equipment (contact tank)			m^2	unit(s)			
	Discharge sewer			m^3/s	unit(s)			
Sludge treatment facilities	Sludge thickening tank			m^3	unit(s)			
	Sludge digestion tank			m^3	unit(s)			
	Sludge washing tank			m^3	unit(s)			2-stage upflow type
	Sludge dewatering equipment			SSkg/hour	unit(s)			
	Sludge incineration equipment			t/day	unit(s)			
	Gas holder			m^3	unit(s)			
Common facilities	Administration block			m^2	block(s)			
	Power receiving and transformer facilities			kVA	set(s)			

Note 1. If there are any facilities not specified in the type column, add appropriately.

2. Enter the equipment manufacturer, etc. in the remarks column.

Table 11-1-7 Typical Format of the Major Equipment History Ledger

Equipment/instrument	30-43	Sludge digestion	: Heat exchanger	Fixed aset code	20-0008	Office name	5		Administration			
Model/type	32-00	Dual pipe type		Acquisition cost		Business name	04-001		Treated area			
Individual name	2	No. 2		Maintenance cost		Year established	36		Service life	20	Service life	56
Maker	47			Maintenance ratio (%)		Form and current			0: Equipment in operation 1: Idle or abolished equipment			

Specifications	No.	Item	Value	Unit	No.	Item	Value	Unit	No.	Item	Value	Unit	Remarks
	①	出力	68000	kcal/H	③				⑤				
	②	圧力	1.5	kg/cm²	④				⑥				
Installation works			0360		Mechanical equipment (digestion tank, equalization tank, etc.) and pipes/valve works								

Instrument code: 005-04-001-30-43-002

Works history [through works]						
Works period	Executed year	Works No.	Works name	Works outline	Execution cost	Contractor
				Treatment plant		

(3) Control of supplementary drawings, etc.

Concerning conduit facilities, supplementary drawings are maintained and archived together with the sewage system ledger. Since there are numerous supplementary drawings in treatment plants and pumping stations, they should be appropriately prepared and archived.

a) Supplementary drawings, etc. for treatment plants and pumping stations

Concerning treatment plants and pumping stations, the drawings necessary for maintenance as well as other equipment test results sheets, strength calculation sheets and user manuals, etc. (hereafter referred to as drawings, etc.) shall be fully prepared and archived with a view to realizing the proper operation of maintenance.

- Preparation of drawings, etc.
  Methods for preparing drawings, etc. should be unified. Doing this will eliminate display disparities in preparation and correction and make it easier to control drawings, etc. for viewing, correcting and archiving, etc.
- Archiving and correction
  Use original drawings for control, archiving and correction in order to enable easy search; moreover, promptly make corrections to drawings when changes arise in on-site facilities. Moreover, at the end of the year, conduct a survey of the revised areas, promptly make corrections where needed and replace the revised drawings in the necessary places.
- Preparation and archiving of other drawings, etc.
  When conducting maintenance, prepare an inventory of other drawings, etc. and control according to that. Moreover, at least once a year, set a day to survey and organize other drawings, etc.

b) Major equipment history ledgers

As was mentioned earlier, equipment ledgers covering the following main items, etc. should be prepared and controlled for maintaining equipment.

- Objective
-
  The objective is to establish a database for control of major equipment and establish an efficient maintenance regime.
- Main stated items
  Equipment name, installation area, installed year, name of installation works, fixed asset code, service life, model/type, specifications/rating/performance, maker, fixed asset evaluation, etc.
- Works history
  Executed year, name of works, outline of execution, contractor, works cost for this equipment
- Preparation and archiving
  At least once a year, set a day to survey and organize works costs.

(4) Purpose of use

Ledgers act as the basis for maintenance of sewers, and they are utilized in various ways for the following purposes. Attention should always be directed towards expanding the scope of use and achieving even greater effective utilization.

a) Utilization in plans and design

- Planning and design of new installation works and rebuilding works
  Gauge the actual state of existing sewer installation and flow capacity and use data for works planning.

b) Utilization in maintenance

- Planning of maintenance activities such as cleaning and repairs, etc.
  Confirm areas that are prone to blockages, areas that are causing maintenance problems and areas that require special structures or other priority maintenance work, and compile specific work plans.
- Inspection and survey of facilities
  Based on information obtained from ledgers, gauge the characteristics of each sewer and

compile a comprehensive survey plan.

Moreover, concerning inverted siphons, storm overflow chambers, outfalls and other facilities that particularly require inspections, investigate location and structure and compile inspection items and implementation plans, etc.

- Cause investigation and examination of countermeasures at times of accidents and disasters
  Based on ledger information for sewers and other facilities, add on-site information, conduct situation analysis, estimate causes and compile restoration work plans.
- Follow-up survey at times of abnormal water quality
  Retracing the flow, identify the source of occurrence, predict the scope of damage and compile effective countermeasures.

c) Utilization in discussions with other operators

- Works execution discussions with other operators
  Based on accurate information concerning existing sewers, discuss methods for protecting facilities from other works.
- Discussions on connection with drainage equipment
  Hold discussions with installing operators upon considering drainage methods, drainage flow, water quality, and impact on sewer mains depending on the installation position, etc. In particular, it is essential to conduct connection discussions with installation operators in line with building construction and development activities.

d) Utilization in liaising with residents

- Examination of response measures to reports from citizens
  Determine conditions and estimate causes based on ledgers and examine effective countermeasures.
- Guidance of drainage equipment
  Offer guidance on the installation or renovation of drainage equipment corresponding to the depth, position, structure and drainage system, etc. of the sewer mains.

e) Utilization in asset management

Utilize for gauging the condition of assets and implementing appropriate control.

(5) Construction of a sewage system ledger control system

Regarding control of sewage system ledgers, it is desirable to consider construction of a system that utilizes geographical information. This refers to geographical information system (GIS) functions in which map information in sewage system ledgers is used in a common database with sewage system facilities information. Such systems make it possible to search the locations and attribute information of facilities and output floor plans and investigative reports relating to facilities.

As conduit facilities become more and more widespread, dissemination rates increase, the volume of information on facilities grows and opportunities for use of information also increase, conventional information control using paper media becomes increasingly time consuming, the information needs to be divided into different locations and utilization becomes increasingly complicated and difficult. The best way to address these problems is to introduce a computer-based sewerage ledger system. Such a system is regarded as key to improving the efficiency and sophistication of facilities management in the sewerage utility.

2) Management of sewer facilities

(1) Objectives of maintenance

Conduit facilities refer to manholes; storm overflow chambers, outfalls, inlets and lateral pipes, etc. and these are key facilities for sewage systems. Together with drainage equipment, such facilities collect sewage and rainwater and carry it to pumping stations, treatment plants or discharge destinations such as rivers, etc.

The objectives of maintenance are to fully gauge the state of facilities, to secure their functions, to extend the lifespan of effective functioning, to prevent negative impacts being exerted on other facilities, and to prevent damage to facilities by other works.

In order to appropriately implement the following contents of conduit facilities maintenance, it is necessary to build a solid maintenance organization, conduct appropriate handing-over of facilities, strengthen hygiene and safety management and conduct thorough public information activities, etc.

- Inspections and surveys
- Cleaning and dredging
- Repairs
- Preservation and protection
- Accident countermeasures
- Water infiltration countermeasures

a) Maintenance of facilities functions

Sewage systems rank in importance with water supply, gas supply, electricity supply and telecommunications, etc. as essential urban lifeline facilities. Considering this, conduit facilities should have the following functions:

- Members of conduit facilities possess ample strength with respect to soil pressure, water pressure and seismic vibrations, etc.
- Conduit facilities possess sufficient water tightness with respect to groundwater and flowing sewage.
- Conduit facilities possess sufficient cross-sections to handle the sewage flow.
- In separate sewer systems, sewage and rainwater flows are totally separated.

Table 11-1-8 shows examples of abnormal phenomena if these functions are not achieved.

In order to ensure that sewage systems fulfill their objectives as lifelines, it is necessary to prepare a maintenance setup that ensures functions even during disasters.

Table 11-1-8 Examples of Abnormal Situations in Conduit Facilities

Abnormal situation in conduit facilities	Structural abnormality	Stability	Corrosion (concrete)
			Abrasion
			Breakage
			Cracking
			Deformation (flexible pipes)
	Functional abnormality	Water tightness	Inflowing water
			Leakage
			Misaligned joints
			Detached packing
		Down flow capacity	Attachment of fats and oils
			Attachment of mortar
			Penetrating roots
			Foreign objects
			Sedimentation
			Reverse gradients
			Sagging, meandering
			Protruding laterals
	management abnormality	Manage-ability	Corrosion of metal footholds
			Abrasion of manhole covers
			Uneven manholes
			Mismatch of manhole covers
			Wrong manhole covers
			Manhole sinkage

b) Extension of facilities service life (reduction of lifecycle costs)

Sewage system managers are required to realize the most rational use of capital that is invested in the construction and maintenance of facilities. It is important to extend the service life of facilities through planned maintenance in consideration of reducing the total amount of capital (lifecycle cost) invested over one cycle of design, construction and maintenance (including removal following degradation).

c) Prevention of adverse impacts on other facilities and damage of conduit facilities caused by other works

If abnormal conditions in underground conduit structure are left unattended, not only will the functions of the said facilities decline even further, but also negative effects will be imparted to other facilities (roads, water supply, electricity, gas and telephone lines, etc.), soil and groundwater, eventually leading to road subsidence and sewage overflows. Additionally, competing works under public roads and large-scale building projects can cause damage to conduit facilities.

Unlike other facilities, since conduit facilities almost always adopt gravity flow, abnormal situations are rarely discovered immediately and they often only come to light after leading to major external problems such as road subsidence or sewage overflows that can trigger even bigger accidents. Planned preventive maintenance must be implemented on such facilities in order to ensure that citizens can live in safety.

(2) Planned maintenance

In order to ensure that conduit facilities fully display their functions, it is necessary to rationally adjudicate facilities functions based on periodic inspections and patrols and to implement planned and appropriate countermeasures while taking the following points into consideration:

- Compilation of maintenance plans
- Maintenance costs reduction effect
- Collection, organization and utilization of data and information
-

As sewage systems become more important and fill the role of urban lifestyle facilities, it is necessary to conduct the maintenance of sewage systems in a planned manner.

Figure 11-1-1 shows the flow of planned maintenance. Based on the basic plan, the cycle of activities comprising patrols and inspections, cleaning, survey, improvements and rebuilding is carried out.

a) Compilation of maintenance plans

Maintenance plans are compiled while referring to the flow chart of maintenance over the standard service life from new installation to rebuilding as shown in **Figure 11-1-2**.

Consideration is given to the following points when compiling plans:

- Divide the target area into districts that can be treated in a single fiscal year.
- Base work around repeated diagnosis of routine inspections (patrols and inspections) and planned surveys (visual inspection surveys, basic camera surveys and TV camera surveys).
- If water infiltration is found to be large as a result of diagnosis, plan detailed surveys (water flow surveys).
- Conduct patrols and inspections in units of a number of blocks, and cover entire districts in a single fiscal year.
- Successively implement visual inspection surveys, basic camera surveys and TV camera surveys assuming the district covered in a single fiscal year to be 1 block. When surveys of all blocks are finished, go back to the first block.
- Based on the diagnosis of survey results, decide the order of priority of repairs and rebuilding (urgent, early, future plan or periodic monitoring) and compile an annual implementation plan for each block.
- Carefully organize and analyze obtained data so that it becomes possible to compile even more effective maintenance plans by accumulating experience of survey, cleaning, repair, rebuilding and other maintenance work.
- Regarding the effectiveness of closed works methods adopted in repair and rebuilding, it is necessary to conduct evaluation by carrying out periodic confirmations after 1 year, a few years or at times of differing environmental conditions (when the groundwater level greatly changes and so on).

b) Reduction of maintenance costs

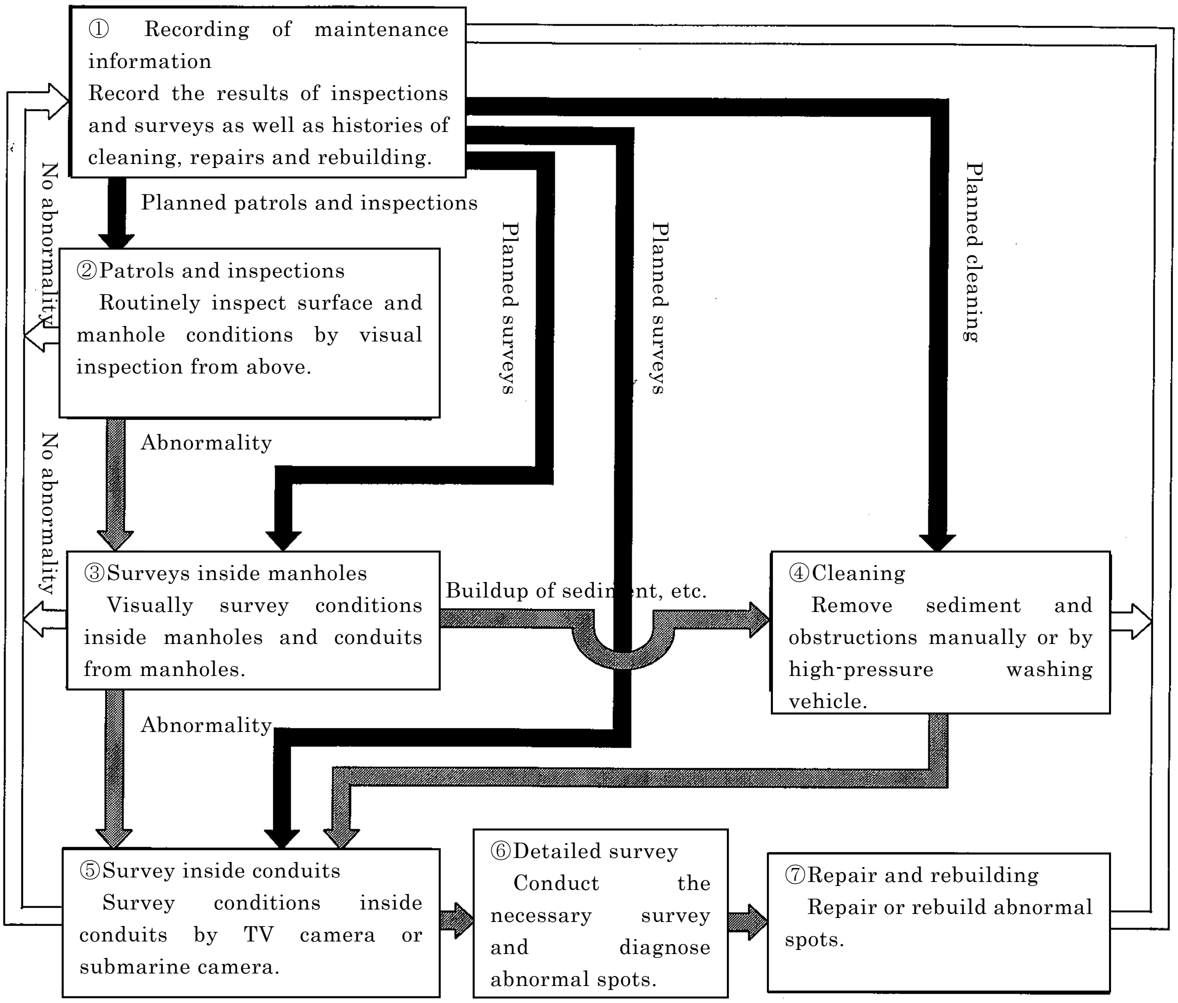
Through carrying out the planned maintenance of conduit facilities, it should be possible to reduce road subsidence accidents. Moreover, major effects can be anticipated in terms of preventing sewage overflows and odor outbreak due to the early discovery of flow obstructions, preventing infiltration of groundwater, etc. and preventing sewage leaks, etc. Moreover, actively implementing maintenance from an early point after the commencement of services enhances the cost-benefit effect, while implementation of planned maintenance eventually leads to reduction of maintenance costs.

c) Collection, organization and utilization of data and information

In order to implement planned maintenance, it is necessary to systematically collect related data and information, to structurally organize it and effectively utilize it.

Information on maintenance starts from completion inspection data (yield drawings, etc.) and covers a wide range of materials such as reports on inspections, surveys, cleaning and repairs, etc., reports on treatment of notifications, etc., reports on accidents such as overflows and road subsidence, and so on. In addition to utilizing such information for responding to situations on-site, it is important to retain it as records. Such recorded information can be effectively utilized upon conducting organization and analysis.

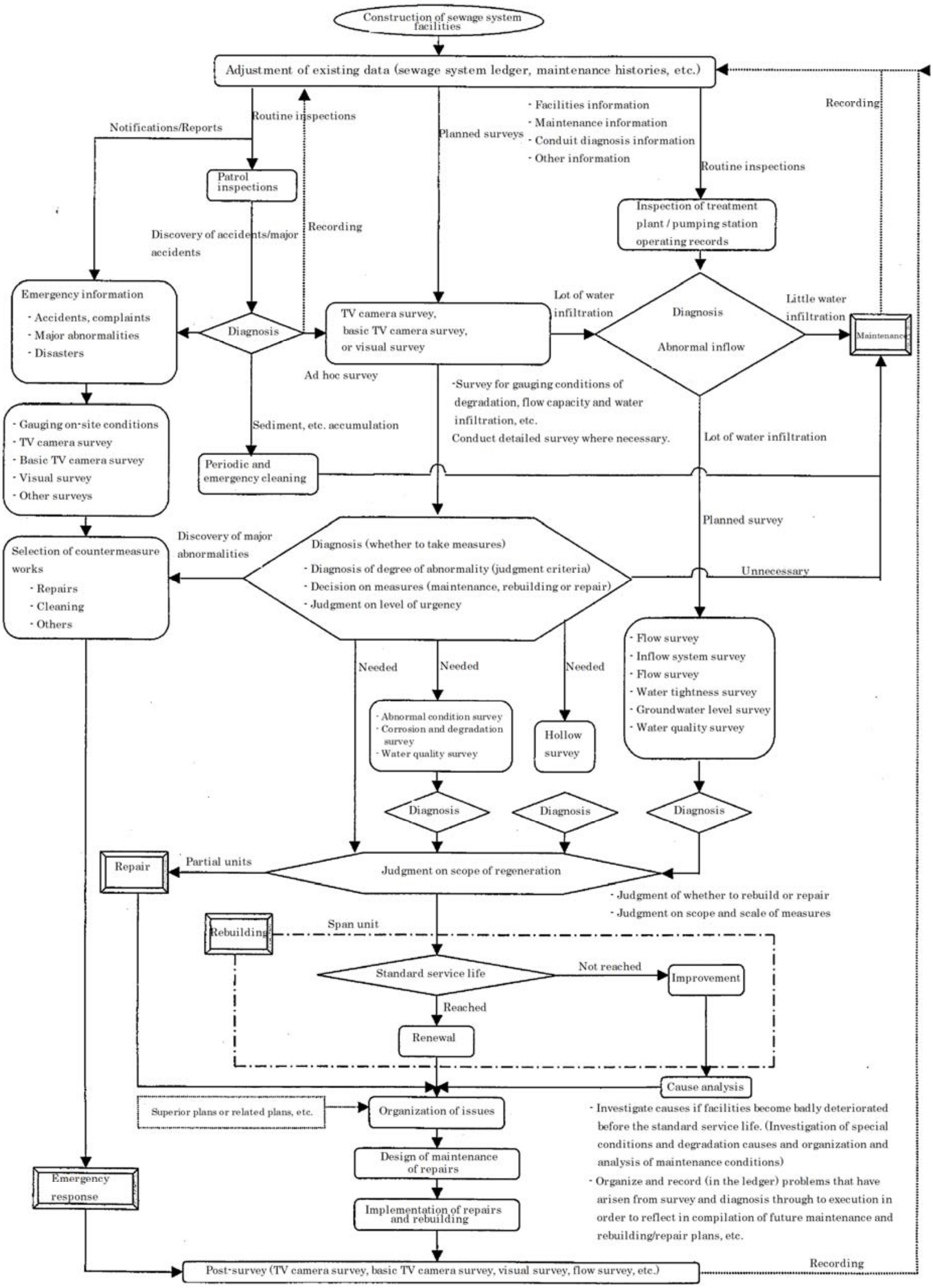
Figure 11-1-1 Flow of Planned Maintenance



※ Repair: Partial restoration of abnormal spots on sewage system conduits through conducting reinforcement and/or replacement.

Rebuilding: Restoration and/or re-laying of sewage conduit facilities in units of sections between manholes.

Figure 11-1-2 Flow Chart of Conduit Facilities Maintenance



(3) Types and management of conduit facilities

The major types of facilities and important points to consider in terms of maintenance are as follows.

a) Pipes

Pipes are installed with the purpose of collecting and removing sewage, and they are divided into closed channels and open channels. Also, in separate sewage systems, pipes are divided into sanitary sewers and storm sewers. Since pipes (conduit channels) are the central facilities in sewage systems, effort must be made to constantly maintain their functions to ensure that flow capacity isn't impeded.

b) Manholes

Manholes are installed at pipeline starting points, points where there are changes in direction, gradient and pipe diameter, etc., points where there are grade differences, points where sewers join, and other points deemed necessary for maintenance purposes. Manhole structures differ according to their purpose of use. Apart from small manholes which cannot be entered by people, it is important to make manholes always accessible; in particular safety must be secured in going up and down.

Display on the manhole cover should clearly show the distinction between 'Sanitary sewage' and 'Rainwater' in the case of separate sewage systems. If manhole covers become worn down or id rattle or grade difference arises between the manhole cover and frame, appropriate safety measures need to be taken. Moreover, in places where cover detachment is likely to occur, covers must be replaced with non-detaching types.

c) Inlets and laterals

Inlets, which have the purpose of collecting sewage from households and factories or rainwater from streets via drainage facilities and side ditches, are divided into house inlets and storm inlets. Meanwhile, laterals are installed with the objective of conveying the sewage collected in inlets into sewer pipes.

Concerning inlets, it is desirable to periodically inspect for accumulated sediment, etc. and to carry out cleaning, etc. Concerning laterals, it is necessary to display ample caution regarding blockage and damage caused by other works, etc.

In separate sewer systems, in addition to clearly distinguishing between storm inlets and house inlets, care must be taken to prevent miss-connections with drainage facilities. Moreover, house inlets are divided into those that receive sanitary sewage from households and those (monitoring inlets) that receive wastewater from industrial pretreatment facilities.

The installing party is required by law to measure the water quality of wastewater from industrial pretreatment facilities, etc. In addition, sewage system managers are required to install monitoring inlets on public roads so that it is possible to monitor the quality and quantity of wastewater from industrial pretreatment facilities, etc. The structure of such inlets should be such that water samples can be easily acquire; moreover, it should be possible to measure flow rate appropriate to the location conditions of the installed site.

Monitoring inlets should be clearly distinguishable from other sewage inlets; moreover, they should be easy to open and close so that industrial wastewater can be properly monitored.

d) Storm overflow chambers

Storm overflow chambers are intended to overflow and remove untreated sewage into the public water body as well as to convey a set quantity of sewage into pumping stations or treatment plants at times of rainfall in combined sewer systems. They comprise an overflow weir, storm discharge sewer and sewage discharge sewer.

e) Outfalls

Outfalls are facilities for discharging treated effluent or rainwater into public water bodies. Since outfalls need to be installed upon holding talks with receiving water body managers to ensure that said water bodies are not adversely affected in terms of water quality or flow, when it comes to performing maintenance, it is necessary to be fully aware of the past history and contents, etc. of all outfalls.

f) Open channels

Compared to closed channels, open channels are more prone to reduced flow capacity caused by illegal disposal of trash and accumulation of plants and sediment, etc. Accordingly, they require appropriate management on routine basis.

g) Inverted siphons

Inverted siphons are installed as a last resort in order to cross rivers or underground structures, and they are composed of inverted sewers and inverted chambers.

Inverted siphons frequently become obstructions in the flow of sewage and sometimes cause sewage overflows or detached manhole covers. Accordingly, more care than in the case of ordinary sewers must be taken to preserve functions and secure flow capacity.

(4) Significance of inspections and surveys

In order to appropriately conduct maintenance to conduit facilities, it is necessary to implement appropriate inspections and surveys based on the long-term viewpoint and to gauge the current conditions of facilities.

Inspections and surveys fill an important role in confirming via fact-finding survey and detailed survey abnormalities that have been discovered by patrols and inspections, determining the extent of abnormality and linking findings to countermeasures such as cleaning, dredging, repairs and rebuilding, etc.

Gauging of the current conditions of conduit facilities is conducted successively in the order of 1) inspection (preliminary survey) and 2) survey (fact-finding survey and detailed survey).

a) Inspections (preliminary survey)

Conduit facilities are patrolled and inspected. Whenever necessary, operating records, etc. are collected from treatment plants and pumping stations and data are organized with a view to clarifying the spots or areas that require survey.

b) Survey

(a) Fact-finding survey

Visual surveys are implemented in order to clarify the abnormal spots or areas in which to implement detailed survey and to obtain data for examining the order of priority of survey, the survey methods and combinations of them.

(b) Detailed survey

Various survey techniques are used in order to clarify the location and condition of abnormal spots and the cause of abnormality, etc. and to obtain data for examining the repair and rebuilding of conduit facilities.

(5) Inspections

Inspections entail gauging the condition of conduit facilities through conducting patrols and inspection of operating records, etc., and providing important information for making maintenance work decisions such as whether or not it is necessary to conduct detailed survey.

Patrol inspections are intended to gauge the condition of roads over conduit facilities, manhole covers, manhole interiors and sewer walls, sediment accumulation and flow conditions as far as can be visible from manholes with a view to gauging the condition of flow facilities.

Observation methods from manholes entail conducting either visual inspection using mirrors and lights or inspection by means of basic TV camera.

Basic TV camera inspections entail attaching a camera and light to the end of a telescopic operating pole, inserting it into the manhole and using it to zoom in on, inspect and survey sewer condition while the surveyor watches conditions on a monitor on the ground surface.

Since patrol inspections are conducted amidst heavy road traffic on the ground surface or under conditions of gas occurrence underground, ample care needs to be taken with respect to traffic safety and securing measures to counter oxygen deficiency and toxic gases, etc.

a) Periodic inspections and ad hoc inspections

Patrol inspections comprise either periodic inspections or ad hoc inspections conducted when functions are impeded, however, routine work generally consists of periodic inspections. Periodic inspections are intended to gauge the flow conditions required to maintain facilities functions, accumulation of sediments and the state of damage of facilities and to conduct inspections, etc. for accident prevention. These activities are systematically planned and records of inspections are prepared.

b) Inspection cycles

Since sewer networks cover wide areas, in order to efficiently patrol and inspect them, it is necessary to divide areas into blocks and implement work in stages. It is also necessary to gauge trends in each area and plan work so that greater emphasis is placed on those areas experiencing a lot of problems. **Table 11-1-9** shows the typical kinds of planned patrol and inspection intervals that are adopted for conduit facilities.

Table 11-1-9 Typical Patrol Inspection Intervals

Division / Years after start of service		Manhole sewers	Inverted siphons	Manhole pumps	Storm overflow chambers	Outfalls	House inlets	Street inlets	Gates
Patrol inspections	0~30 years	Once / 3 years	Once / year	Once/ month	Once / 2 years	Once / year	Once / 3 years	Once / 3 years	Once / 6 months
	More than 30 years	Once / year	Once / year	Once/ month	Once / year	Once / year	Once / 3 years	Once / 3 years	Once / 6 months

(6) Surveys

Surveys have an important role in gauging via various techniques the condition and extent of abnormalities that have been discovered in inspections, and linking findings to countermeasures such as cleaning, dredging, repairs and rebuilding, etc.

Most of the abnormalities in sewers can be confirmed by visual investigation, however, for example, it is also sometimes necessary to use investigation and test techniques in order to check the water tightness of sewers that are out of sight.

It is desirable to carry out visual investigations at regular intervals. **Table 11-1-10** shows the typical kinds of survey intervals adopted for manhole and sewer surveys.

Table 11-1-10 Typical Survey Intervals for Manholes and Sewers

Item	Implementation Site	Years after start of service	Interval	Remarks
Visual investigation inside manholes	Inside manholes and upstream / downstream sewers	0~30 years	Once / 5 years	
		More than 30 years	Once / 3 years	
Diving visual investigation	Inner diameter 800 mm or more	0~30 years	Once / 10 years	Including laterals
		More than 30 years	Once / 7 years	Including laterals
TV camera survey	Inner diameter less than 800 mm	0~30 years	Once / 10 years	Including laterals
		More than 30 years	Once / 7 years	Including laterals

a) Visual investigations (abnormal conditions, damage and sediment accumulation, etc.)

Visual investigations are implemented in cases where abnormal conditions, damage, sediment accumulation and other abnormalities are discovered in patrol inspections. Visual investigation methods are described below. Also, abnormal conditions (reverse gradient, sagging, meandering, deformation, etc.), damage (breakage, cracking, etc.) and sediment accumulation, etc. that are intrinsically linked to visual inspections are described.

Visual surveys comprise visual surveys, basic TV camera surveys and TV camera surveys.

- Visual survey

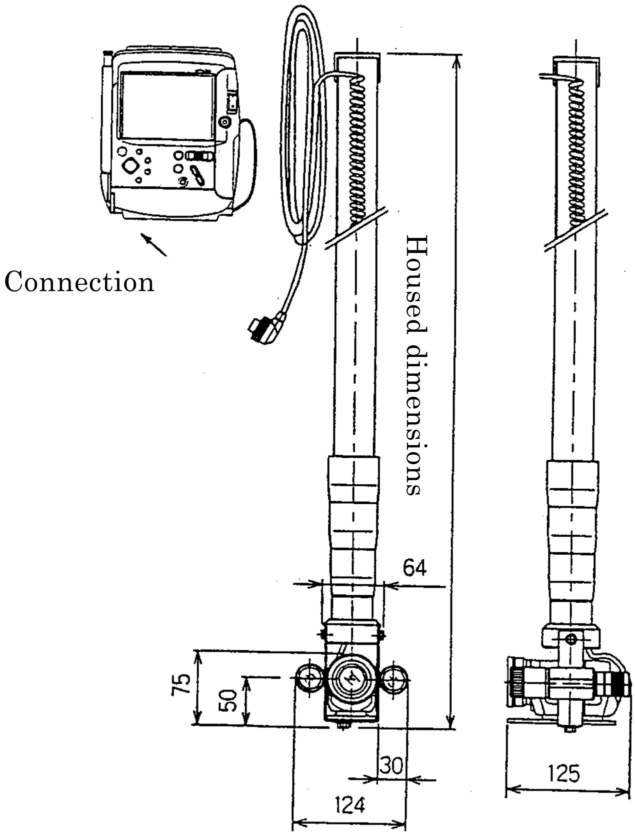
  Visual survey entails a surveyor directly entering conduit facilities and gauging conditions by naked eye. In the case of sewer mains and laterals with diameter of less than 800 mm, the surveyor uses a mirror and powerful light from manholes and inlets, whereas in the case of sewer mains that have inner diameter of more than 80 mm and are large enough to walk in, the surveyor conducts diving survey.

  In cases where there is risk of sulfur oxide generation or oxygen deficiency or such conditions have already been confirmed, ventilation is conducted before work, and work is only started after confirming that oxygen content is 18% or more and that the sulfur oxide content is no higher than 10 ppm as well as stirring accumulated sediment to check for safety. Ventilation should be continued until it has been confirmed that no more personnel are inside sewers.

- Survey by basic TV camera

  As is shown in **Figure 11-1-3**, the basic TV camera comprises a camera and light attached to the end of a telescopic rod. This is inserted via a manhole from above ground, where the surveyor zooms in on, inspects and surveys sewer conditions while watching the findings on a monitor.

Figure 11-1-3 Outline View of the Basic TV Camera



- Survey by TV camera

  TV camera surveys as a rule are implemented in sewer mains and laterals having inner diameter of 150~800 mm. They are also conducted in sewers measuring more than 800 mm in cases where surveyor cannot enter the sewer because the flow rate is too fast or hazardous gases are expected.

  TV camera surveys can be implemented directly by the sewage system managers or can be contracted to private subcontractors, however, in view of problems surrounding equipment ownership and personnel, it is better to consign such work to contractors.
  In addition to routine inspections and surveys, TV camera surveys are implemented over a wide scope of urgent surveys, yield confirmation surveys, handover inspection confirmation surveys and surveys to gauge impacts of other works.

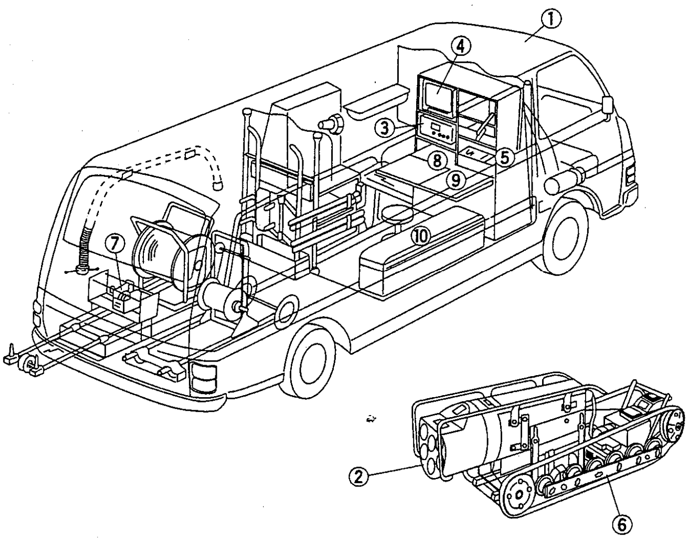
A. Types of TV camera

TV cameras used in sewer mains can either be the self-propelled or traction type, however, in recent years, work is increasingly performed using TV camera trucks equipped with self-propelled cameras. Filming techniques entail either direct filming, in which the entire view inside sewers is shown, or lateral filming, in which abnormal areas or localized spots are shown.

Push-in direct filming TV cameras are usually used to survey lateral sewers. Work is carried out through connecting the TV camera and a vehicle power source or generator to a video and monitor unit, however, work in combination with a TV camera truck is common. Moreover, in recent times, cameras that can conduct lateral viewing, adjust ground and ceiling in images and survey laterals from sewer mains have been developed.

Figure 11-1-4 shows the outline view of the sewer main TV camera and TV camera truck.

Figure 11-1-4 Sewer Main TV Camera and TV camera truck



① TV camera truck (2t)
② TV camera (color)
③ Control panel
④ Monitor TV
⑤ Video tape recorder
⑥ Camera head tractor
⑦ Range meter
⑧ Word typewriter
⑨ Photography equipment
⑩ TV power source

B. TV camera survey record sheet
Conduit abnormalities that are discovered in the TV camera survey are recorded onto video tape and photographs, etc. according to judgment criteria. However, since it takes time to grasp or search survey results in image form alone, results are also recorded on survey record sheets. **Tables 11-1-11** through**11-1-14** show standard formats of survey record sheets.

Consideration should also be given to electronically processing survey record sheets. Forms or edited video digests that extract only abnormal spots are also prepared.

- Abnormal conditions survey

Generally, sewers are designed so that sewage flows by gravity, however, gradient and pipe shapes tend to deform as a result of uneven subsidence and external forces such as earth pressure and load, etc.

This survey aims to investigate such abnormal conditions, grasp flow capacity and acquire data for compiling countermeasures if necessary.
Survey can be conducted by direct measuring in cases where survey staff can enter manholes or large sewers, however, TV cameras or other specialized equipment are used to survey conditions inside small diameter sewers.

- Damage survey

Targeting spots where damage has been discovered in conduit facilities, conduct survey in order to confirm conditions and investigate the causes.
A. Confirmation of conditions

Confirm the state of damage by naked eye or TV camera, and record the position and condition of the damage on ground plans and longitudinal section views, etc.

Table 11-1-11 General Survey Sheet

	Upstream manhole					Sewer									Downstream manhole				
No	Section	Mesh	No.	Manhole	Manhole	Upstream pipe depth	Pipe type	Pipe diameter	Distance between manholes	Number of pipes	Number of sockets	VTR No.	Photo No.	Downstream pipe depth	Section	Mesh	No.	manhole type	Manhole depth

Table 11-1-12 Survey Aggregate Sheet

	Upstream manhole No.				Downstream manhole No.				Pipe breakage			Pipe corrosion			Pipe cracking			Pipe joint misalignment			Pipe sagging or meandering			Mortar attachment			Water infiltration			Lateral protrusion			Oil attachment			Tree root infiltration			Total			Road type		Length between manholes (m)	Pipe diameter (mm)	Pipe type	Number of pipes	VTR or photo No.
No	Section	Mesh	No.	Branch	Section	Mesh	No.	Branch	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	Road manager	Paveme					

Table 11-1-13 Sewer Main Survey Record Sheet

Route No.

Upstream manhole No.							
Section	Mesh	No.	Branch	Manhole type	Manhole depth	Pipe top depth	Manhole cover type
					m	m	
Inspection inside manhole							

Pipe type	Pipe diameter	Distance between manholes
	m	m

Downstream manhole No.							
Section	Mesh	No.	Branch	Manhole type	Manhole depth	Pipe top depth	Manhole cover type
					m	m	
							Inspection inside manhole

Joint section	Number of joints	Pipe opening	Number of pipes [ ]
	Photo No.		Number of sockets [ ]
			Number of defective pipes [ ]
	Contents		VTR No. [ ]
			Counter No. [ ]
			[ ]
			Construction year [ ]
Main pipe	Number of pipes		Occupied position
	Photo No.		1. Roadway of national route, prefectural route or city road
			2. Back way, inside footway, inside guardrail
	Contents		3. Others
			Applicable No.
Socket section	Lateral No.		
	Photo No.		
	Contents		
Remarks			

Abnormal contents / Abnormal area	Pipe breakage			Pipe corrosion			Pipe cracking			Pipe joint misalignment			Pipe sagging and meandering			Mortar attachment			Infiltration water			Lateral protrusion			Oil attachment			Tree root infiltration			Others			Total			Remarks
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Joint																																					
Main pipe																																					
Socket																																					
Manhole																																					
Total																																					

Note: In the remarks column, in addition to the conduit damage conditions, state the road traffic conditions, living environment, adjacent works, causes of damage, damage progression and newness of damage, etc.

Table 11-1-14 Lateral Survey Record Sheet

NO.

Upstream manhole	Section	Mesh	No.	Branch

Downstream manhole	Section	Mesh	No.	Branch

Inlet No.																			
Survey distance (m)																			
Number of pipes																			
Left side / Contents: Inlet																			
Left side / Contents: Inside lateral																			
Lateral pipe type																			
Lateral pipe diameter																			
Photo No.																			
																			VTR No. [ ] Counter No. [ ] [ ]
Inlet No.																			Occupied position 1. Roadway of national route, prefectural route or city road 2. Back way, inside footway, inside guardrail 3. Others Applicable No.
Survey distance (m)																			
Number of pipes																			
Right side / Contents: Inlet																			
Right side / Contents: Inside lateral																			
Lateral pipe type																			
Lateral pipe diameter																			
Photo No.																			
Remarks																			

Abnormal contents / Abnormal area	Pipe breakage			Pipe corrosion			Pipe cracking			Pipe joint misalignment			Pipe sagging and meandering			Mortar attachment			Infiltration water			Lateral protrusion			Oil attachment			Tree root infiltration			Others			Total			Remarks
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Left side																																					
Right side																																					
Total																																					

Note: In the remarks column, in addition to the conduit damage conditions, state the road traffic conditions, living environment, adjacent works, causes of damage, damage progression and newness of damage, etc.

B. Investigation of causes

Causes of damage are broadly divided into natural causes such as uneven ground subsidence, aging and corrosion, etc. and external causes such as impact of other works and bad quality wastewater from business establishments, etc.

C. Response to road subsidence accidents

In cases where road subsidence occurs, since damage to conduit facilities is often the cause, it is necessary to conduct urgent survey. In such cases, out of consideration of impacts on other buried structures, it is necessary to survey the type, shape and position of nearby underground structures, so the managers of said structures are immediately contacted and requested to attend the surveys.

- Survey of sediment, etc. accumulation

A. Types of sediments

Sediments comprise both natural sediments and illegally disposed sediments, and it is necessary to accurately distinguish these.

B. Impact of sediments

When sand and soil sediment becomes excessive, flow capacity is diminished and this can lead to water inundation and odor. In combined sewer systems, since sediments can cause sewage to flow out of storm overflow chambers during rainfall and lead to pollution of the public water body, surveys of sedimentation should be carried out periodically.

C. Utilization of records

The amount of sand and soil sedimentation varies depending on local conditions, sewer pipe diameter and gradient, etc. In areas that are prone to accumulation, conditions are gauged through collecting and organizing survey results data.

b) Water infiltration survey (bad connections, water flow and water tightness)

Water infiltration from conduits imparts various negative impacts on maintenance of conduits and treatment facilities. It can diminish flow capacity, cause inundation and lead to water quality deterioration and increased costs. Additionally, it can draw in sand and soil from the ground around conduits, hollow out the said ground and lead to road subsidence, as well as bring about accumulation of sediments inside conduits.

Infiltrating water comprises groundwater and rainwater, and groundwater is fuehrer divided into seawater and other groundwater. The causes of water infiltration are sometimes in the sewers and sometimes on the side of drainage equipment.

Accordingly, it is necessary to clarify the amount and route of water infiltration through combining surveys of wrong connections, flow rate and water tightness, etc., and to prepare data for examining ways to repair and rebuild conduit facilities.

c) Corrosion and degradation survey

Degradation diagnosis technologies for reinforced concrete structures have more or less been established and progress is being made in the development of various inspection methods and instruments. However, due to the special environment that surrounds conduit facilities, there are problems with directly applying such techniques. Currently, visual surveys and TV camera surveys are the most common techniques, while sampling analysis, corrosion rod insertion and judgments based on water quality and gas analysis are conducted in cases where sewers can be entered.

d) Installed environment survey (groundwater level and hollowing)

Sewers buried underground are greatly affected by the state of ground and groundwater, etc. surrounding the pipes and the quality of sewage inside.

Since ground hollowing occurs when groundwater, rainwater and soil and sand enter sewers from non-watertight spots (joints and broken parts, etc.), it is necessary of course to check the water tightness of sewers and the conditions of groundwater around them. If the groundwater level rises approximately 60 cm above the base of sewer pipes, water infiltration tends to increase dramatically. Furthermore, since inflowing sewage to sewers (especially concrete pipes) can cause degradation to pipe members, it is necessary to constantly watch for bad quality sewage in conduit facilities and treatment plants.

e) Records and their utilization

The findings of inspections and surveys are recorded in detail and utilized for conducting appropriate maintenance of conduit facilities. Inspection and survey results are recorded in detail on the following kinds of formats. Moreover, in order to reflect the results of inspections and surveys in the appropriate maintenance of conduit facilities, they are reported to repair personnel (or departments). Since data of these types of records are easy to control, archive and analyze and they contribute to reducing manpower and improving efficiency in maintenance work, they are used with computers. They should also be used in connection with sewage system ledger control systems.

- Inspection and survey sheets
  Immediately following a patrol inspection, an inspection and survey sheet should be prepared to record the results. **Table 11-1-15** shows an example of an inspection and survey sheet.
- Daily logs
  Daily logs are used to record the results of routine work and comprise work logs and operation logs, etc. In addition, various other types of daily log are prepared according to necessity. **Table 11-1-16** shows an example of a work log.
- Monthly reports
  Monthly reports are prepared by compiling various kinds of daily logs. They divide the maintenance conditions of facilities into regular contents and ad hoc contents and provide data helpful in building planned work setups, personnel assignments and budgets. In particular, when monthly reports on cleaning and dredging are recorded and archived according to each location and year, they can be utilized in discovering spots prone to sediment accumulation and compiling repair and rebuilding plans. **Table 11-1-17** shows an example of a maintenance monthly report.

Table 11-1-15 Sample Inspection and Survey Sheet

<table>
<tr><td colspan="3">Inspection and Survey Sheet</td><td>Serial No.</td><td colspan="2"></td></tr>
<tr><td colspan="2">Place
(manhole No., etc.)</td><td colspan="4"></td></tr>
<tr><td>Inspection date</td><td colspan="2"></td><td>Inspector</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Inspection items</td><td>Manhole cover</td><td colspan="4">Abrasion Rattle Grade difference Missing walkway Breakage, Position unknown</td></tr>
<tr><td>Manhole interior</td><td colspan="4">Corrosion Base breakage Water infiltration Foothold corrosion</td></tr>
<tr><td>Sewer</td><td colspan="4">Corrosion Breakage joint misalignment Poor gradient Water infiltration
Tree roots Sediment / mortar Road surface subsidence</td></tr>
<tr><td>Inlet</td><td colspan="4">Cover (no breakage) Grade difference Corrosion Breakage
Invert breakage Sediment, etc. Position unknown Odor</td></tr>
<tr><td>Lateral</td><td colspan="4">Breakage Misalignment Sediment, etc. Road surface subsidence</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Survey date</td><td colspan="2">. .</td><td>Surveyor</td><td colspan="2"></td></tr>
<tr><td>Survey results</td><td colspan="5"></td></tr>
<tr><td>Work</td><td>·Necessary
·Unnecessary</td><td colspan="4">☐ Subcontracted
☐ Direct management</td></tr>
<tr><td>Work consignment date</td><td colspan="2">. .</td><td colspan="3">Scheduled work date . .</td></tr>
<tr><td>Work completion date</td><td colspan="2">. .</td><td colspan="3"></td></tr>
<tr><td>Remarks</td><td colspan="5"></td></tr>
</table>

Table 11-1-16 Sample Work Log Sheet

Work Daily Report

Date: Weather:

Complaint / Accident handling		Reception No.	Received date	Address	Work contents	Operator	Materials used	Special notes
	1							
	2							
	3							
	4							

Sewer main cleaning														Name of cleaned area	Daily total
	Pipe diameter (mm)													Drainage district (treatment district)	
	Directly managed workers														Persons
	Subcontracted workers														Persons
	Cleaned sediment													System No.	㎡
	Cleaned length														m

Manhole work	Directly managed work	Name of repaired area	Drainage district (treatment district)	System No.	Subcontracted work	Name of repaired area	Drainage district (treatment district)	System No.	Materials used	Daily total
	Work contents				Work contents					

Street inlets and laterals	Directly managed work	Name of repaired area	Drainage district (treatment district)	System No.	Subcontracted work	Name of repaired area	Drainage district (treatment district)	System No.	Materials used	Daily total
	Work contents				Work contents					

House inlets and laterals	Directly managed work	Name of repaired area	Drainage district (treatment district)	System No.	Subcontracted work	Name of repaired area	Drainage district (treatment district)	System No.	Materials used	Daily total
	Work contents				Work contents					

Maintenance attendance	① Party requested to attend		② Party requested to attend		③ Party requested to attend		Next day continuation
	Attended site		Attended site		Attended site		①
	Attendance document No.		Attendance document No.		Attendance document No.		
	Attended time		Attended time		Attended time		②
	Responsible officer		Responsible officer		Responsible officer		③

Table 11-1-17 Sample Maintenance Monthly Report

Maintenance Monthly Report

Date:

Complaint / Accident handling	Complaint type	1. Laterals	2. Inlets	3. Manholes	4. Road surface	5. Odor	6. Others	Grant total
	Number of cases							

Main pipe cleaning																Total
	Pipe diameter (mm)															
	Directly managed workers															
	Subcontracted workers															
	Cleaned sediment															
	Cleaned length															

Manhole repair	Type	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	Special	Directly managed	Subcontracted	Total
	Cover replacement											
	Mouth repair											
	Side block repair											
	Noise											

			Directly managed work	Subcontracted work	Total
Street inlets and laterals	New	Street inlet	places	places	
		Lateral	places	places	
	Repaired	Street inlet	places	places	
		Lateral	places	places	
House inlets and laterals	New	Street inlet	places	places	
		Lateral	places	places	
	Repaired	Street inlet	places	places	
		Lateral	places	places	

Maintenance attendance	Road manager	Gas	Underground power line				Other

Special notes	

g) Cleaning

Cleaning is performed in order to sustain the functions of conduit facilities.

- Objectives of cleaning

When solids and sediment in sewage accumulate inside conduit facilities, not only does this cause diminished flow capacity and blockage but also generation of odor and toxic gases. Accordingly, it is necessary to appropriately conduct cleaning and dredging and to conduct the appropriate maintenance of sewers in order to secure flow capacity.

Also, when inspecting and surveying damage to conduit facilities and checking for water infiltration, etc., it is necessary to conduct cleaning and dredging in advance.

- Classifications of cleaning

Cleaning is generally classified into urgent cleaning, periodic cleaning and cleaning before surveys.

A. Urgent cleaning

Urgent cleaning is carried out in cases where information (complaints or notifications) is received from residents or when odor and overflow, etc. are discovered by patrol inspections or surveys. In such cases, the cleaning should be immediately implemented so that the causes of abnormality are removed and normal conditions are restored. Since it is also necessary to investigate the causes of occurrence in such cases, guidance and improvement are also planned. It is important to record these activities and reflect the contents in future cleaning plans and patrol inspections.

B. Periodic cleaning

Rather than only implementing cleaning when blockage or sedimentation are discovered, it is desirable to also implement periodic cleaning of conduit facilities.

The degree of sediment and sludge accumulation differs according to each spot, however, areas that require frequent urgent cleaning should be patrolled and inspected with added priority, while other areas should be subjected to periodic cleaning based on the results of routine patrol inspections and surveys. **Table 11-1-18** shows criteria for determining when cleaning should be conducted according to the state of conduits. Moreover, **Table 11-1-19** shows a rough guide to intervals for implementing periodic cleaning.

- Preliminary cleaning for surveys

Washing and cleaning are carried out in advance of surveys inside conduit facilities.

Table 11-1-18 Sample Criteria for Conducting Cleaning

Division	Criteria	Remarks
Sludge, sand and soil accumulation	5~20% accumulation	Consider economy, subsidence and sagging conditions
Fat an oil attachment	When attachment is confirmed	Fat and oil builds up and causes blockage. Survey sources and offer guidance
Mortar attachment and accumulation	When attachment or accumulation are confirmed	This causes blockage. Survey sources and offer guidance
Infiltrating roots	When infiltration is confirmed	This builds up and causes blockage. Plan and implement steps to prevent infiltration.
Foreign materials infiltration (disposal)	When confirmed	This causes blockage. Plan and implement removal methods.
Sagging, subsidence, stagnation	When confirmed	Sludge, etc. tends to accumulate. Examine causes of harmful gas and cleaning intervals.

Table 11-1-19 Rough Guide to Periodic Cleaning Intervals

Facility or region	Years in service	
	0～30 years	30 years～
Sewers	Once / 5 years	Once / 5 years
Manholes	Once / 5 years	Once / 3 years
Inverted siphons	Once per year	Once per year
Manhole pumps	Once / 3 months	Once / 3 months
Storm overflow chambers	Once / 2 years	Once per year
Outfalls	Once per year	Once per year
House inlets	Once / 5 years	Once / 5 years
Street inlets	Once per year	Once per year
Laterals	Once / 15 years	Once / 5 years
Gates	Once per year	Once per year

3) Maintenance of pumping stations

Pumping stations have the functions of conveying sewage collected in conduit facilities to treatment plants and discharging rainwater into the public water body.

Pumping stations are used to pump sewage in cases where, 1) sewers are buried to extreme depths, 2) cases where rainwater cannot be naturally discharged into public water bodies, and 3) cases where inflowing sewage to treatment plants cannot be treated by natural gravity flow. Pumping stations also have the function of quickly removing sewage and rainwater from drainage districts to prevent or alleviate flooding, secure pleasant living environment and adjust the water flow so that treatment plants can be efficiently operated.

In order for pumping stations to fulfill these functions, it is necessary to conduct routine maintenance. It is also important to main close communications with treatment plants so that pumping stations are able to fulfill their role in the sewage treatment system. Pumping stations are classified as follows according to purpose.

- Storm water pumping stations
  Storm water pumping stations are independent pumping stations for pumping and discharging rainwater to public water bodies from low-lying districts where rainwater cannot be drained by natural flow.
- Relay pumping stations
  Relay pumping stations are installed in cases where conduit lines would become very long or, due to topographical circumstances, sewers would need to be buried to very deep levels in order to convey sewage to treatment plants by means of gravity flow. Since sewer construction costs become expensive and maintenance is very difficult when sewers are buried deep, relay pumping stations are established in order to raise the sewage en-route and convey it to the next pumping station or treatment plant.
- Pumping stations inside treatment plants
  Pumping stations inside treatment plants are established in order to lift the treated effluent to a height from which it can be discharged into the public water body.

The following sections describe maintenance activities in relay pumping stations and pumping stations inside treatment plants.

(1) Composition of pumping stations

a) Inflow gate

The inflow gate is installed at the entrance to the pumping station and fills the purpose of stopping and adjusting the flow of sewage.

b) Grit chamber

The grit chamber settles and removes sediment in sludge and removes trash, etc. from sewage via screen equipment. Through doing this, the grit chamber helps prevent blockage and abrasion of pumps, accumulation of sediments inside treatment facilities and contamination of discharge destinations.

c) Pumping equipment

Pumping equipment for lifting sewage is the primary equipment in a pumping station. It is powered by generator or internal combustion engine.

d) Electrical equipment, generator equipment and instrumentation equipment

Electrical equipment, generator equipment and instrumentation equipment are installed in order to operate systems and instruments, supply power during blackouts and implement control. Electrical equipment is further classified into power receiving and transforming equipment, distribution equipment and storage battery equipment.

(2) Maintenance of gate equipment

The grit chamber inflow gate is important for controlling the flow of incoming sewage to the pumping station, selecting the used sedimentation tanks and number of tanks and preventing water infiltration to sedimentation tanks in cases where the base of tanks is lower than the ground level.

Types of gate equipment are as follows: - motor-driven gate, - hydraulic gate, and - manual gate.

a) Inspection and maintenance of motor-driven gates

- Outline of structure

  In the case of a motor-driven gate, rotation of the electric motor is decelerated by worm gears and spur wheel, a stem bush is turned, and the gate is opened and closed by bitten spindles. Concerning the power transmission method, screw systems and pin-rack systems, in which power is transmitted to inside the switchgear, which turns to transmit it to a rack valve rod, which opens and closes the door. An opening and closing speed of around 0.3 m/minute is generally adopted. Moreover, a manual operating handle is sometimes installed for limit switch adjustment and operation during blackouts.
- Inspections and maintenance

  Inspections and maintenance of motor-driven gates are implemented as follows.

  A. In order to prevent depletion of lubricant, infiltration by metal powder or emulsification caused by infiltration by water, inspections are conducted as required in consideration of operating frequency, and lubrication, greasing and parts replacement should be carried out.

  B. When frequency of operation is not so high, it is necessary to confirm that switching between motor-driven and manual operation can be certainly performed around once per month over the scope that doesn’t hinder operations. Since corrosion of the door stop and shaft can cause operation failure, testing of full opening, full closing and own-weight downward motion should be implemented periodically.

  C. Because the spindle operation can be impeded when it bites foreign objects or experiences abrasion or rusting, it is desirable to conduct cleaning and greasing at appropriate intervals.

  D. If gates are installed outdoors or underground, since rainwater and moisture often infiltrate the decelerator mechanism and cause rusting, particular care needs to be shown concerning maintenance and inspection.

  E. It is desirable to check contact operation of the limit switch when opening and closing or around once per month.

  F. When adjusting the position of the limit switch, open or close the gate almost to the opening/closing threshold by motor, perform the final opening/closing action manually, and set the operating point of the limit switch upon confirming that it has reached the threshold.

  G. The torque switch is adjusted according to the graduations in the user manual and test results sheet; it is not desirable to raise the setting graduation unless there is a change in conditions of use.

  H. Adjustment of limit switch and torque switch settings is absolutely necessary when conducting disassembly work, however, other than those occasions it shouldn’t be performed.

  I. When a brake is attached, care is required when opening and closing the gate because rusting of the rusting of the brake lifting device sometimes prevents operation. Also, if braking performance fails due to abrasion of the clamp, it is necessary to adjust the clamp.

  J. When humidity becomes high inside the limit switch box, since this can lead to wiring terminal corrosion and limit switch failure and so on, it is necessary to conduct periodic inspections.

  K. In the case of gates that come down by their own weight, the electromagnetic clutch should be tested around once per month to make sure that the gate will work in the event of emergency.

b) Inspection and maintenance of hydraulic gates
c)

- Outline of structure
  The switchgear of a hydraulic gate is composed of a hydraulic unit consisting of a hydraulic pressure source ad control valve, a control panel and a hydraulic cylinder, etc. Since this type of gate can be easily operated during electricity blackouts through utilizing its own weight (an accumulator is also sometimes installed as a pressure source to ensure certain operation), it is frequently adopted for grit chamber inflow gate systems.
- Inspections and maintenance
  Inspections and maintenance of hydraulic gates are implemented as follows.
  A. Since corrosion of the door guide plate and shaft can lead to operation failure, testing of full opening, full closing and own-weight downward motion should be implemented periodically.
  B. Beware of oil leaks in the pipelines and operating valves, and immediately conduct repairs when leaks do occur. Moreover, exposed pipes and piping distances should be kept as short as possible to ensure that oil leaks can be quickly discovered.
  C. Always keep the oil level inside the oil tank at or above the prescribed level to ensure that that hydraulic pump doesn't suck in air.
  D. In order to investigate the state of degradation of operating oil, it is advisable to open the drain valve and periodically implement sampling analysis.
  E. It is desirable to inspect valve operations and upper and lower settings of valves around once per month to ensure they are kept in normal condition. It is also desirable to operate the backup hydraulic pump around once per month.
  F. When there is a lot of oil leakage around piston packing and piston road seals inside the hydraulic cylinder, the packing should be replaced. Moreover, when checking for oil leaks, the amount the gate comes down should be measured after leaving it for a few hours after opening it fully or half way and closing the hydraulic cylinder upper and lower pipes.
  G. If the safety valve (relief valve) pressure setting is inappropriate, since this can lead to trouble with the hydraulic cylinder, rod and gate, the pressure should be confirmed during maintenance to ensure that suitable pressure for opening and closing is maintained.

d) Inspection and maintenance of manual gates

- Outline of structure
  Manual gates are broadly divided into the horizontal handle type, the bevel gear type and the worm gear type, and they are used in cases where the frequency of use is low and not urgent.
- Inspections and maintenance
  Inspections and maintenance of manual gates are implemented as follows.
  A. Since corrosion of the door guide plate and shaft can lead to operation failure, testing of full opening and full closing should be implemented periodically.
  B. Because the spindle or gear operation can be impeded when exposed parts bite foreign objects or become worn or rusted, it is desirable to conduct cleaning and greasing at appropriate intervals. Gears that are housed in sealed gearboxes do not need to have grease replaced for a number of years, however, it is a good idea to re-grease machines when they are disassembled for periodic inspection or repair purposes. It is also desirable to periodically oil and lubricate the oil bath and grease cups, etc. and move the gate slightly up and down in order to test operation.
  C. In cases where the spindle is long and stopped from swaying, since dirt and dust can accumulate in it and make operation feel heavier, it is necessary to periodically implement inspections and cleaning.
  D. It is desirable to inspect for damage and corrosion on the switchgear cover, and to immediately carry out repairs and coating when problems are discovered.
  E. Since the detachable part that serves as a stop-log is prone to operation failure due to rusting of the bearings section, it is necessary to periodically perform lubrication and make sure that operation is OK at least once before use.

(3) Maintenance of screen equipment

Since sewage contains suspended solids such as garbage and wood pieces, etc., it is necessary to remove these before they enter pumping stations and treatment plants, otherwise machines in such facilities could be damaged. Screen equipment is intended to prevent such problems.

a) Outline of structure

There are two types of screen equipment, i.e. manual scraping type and mechanical scraping type. Mechanical scraping types are further divided into continuous screens and intermittent types comprising intermittent screens or rope-winding screens, etc.

Screen equipment needs to be operated in close linkage with inflow gat equipment, grit removal equipment and lifting pumps.

b) Inspections and maintenance

Inspections and maintenance of screen equipment are implemented as follows.

- Install the screen in such a way that it can certainly capture and collect screenings.
- Since mechanical scraping screens have a wide variety of structures and mechanisms, maintenance and inspections should be implemented according to the specifications of each. Moreover, rough guides for abrasion and corrosion should be stipulated for each part so that repairs and replacements can be implemented in planned fashion.
- Equipment that isn’t used all the time should be operated for around 10~15 minutes at least once per day in order to make adjustments.
- Areas of peeled coating should be repaired immediately before corrosion takes hold.
- During operation, operators should watch out for beating, creaking and vibration with a view to discovering abnormalities.
- Since screens tend to become dirty, strive to clean them and accessory equipment and also keep deodorizer and insect repellent on hand.

(4) Maintenance of grit removal equipment

Grit removal equipment is intended to remove sediment that has settled in sedimentation tanks in order to prevent equipment in pumping stations and treatment plants becoming worn out and blocked, etc.

a) Inspection and maintenance of the bucket conveyor grit collector

- Outline of structure

  Since the drive section of the bucket conveyor grit collector is above the water surface, this equipment has the advantage of being able to scrape up grit while passing through sewage. However, the chain, bucket and sprocket wheel, etc. are prone to corrosion and abrasion because they are partially underwater. When collecting grit, because the shoe attached to the bucket slides along the rail, this part is especially prone to wear and tear.

  Moreover, in cases of intermittent operation at times of rainfall, since the inflow of large amounts of sediment can bury the bucket and cause operation to cease, it is necessary to switch to continuous operation or at least increase the operating frequency.

  In response to the said burial under sediment, it is better to adopt models that can autonomously extricate from such situations or models in which the bucket conveyor is raised about the water surface, and such types are suited to pumping stations that receive large quantities of sediment in single bursts.
- Inspections and maintenance

  Inspections and maintenance of grit removal equipment are implemented as follows.

  A. Chain and sprocket wheel

  Because the chain, sprocket wheel and bucket are subject to a lot of corrosion, and sand tends to infiltrate the chain and sprocket wheel, causing the chain to stretch and the sprocket wheel to become worn, it is necessary to implement inspections all the time.

  Since the chain tends to become elongated (0.05~0.1% of the total chain length) in the first few days of use, it should be re-inspected and the looseness adjusted.

  When the sprocket wheel is used for a long time, because the biting parts become worn and the chain stops detaching smoothly, it is necessary to replace. As a stopgap measure, it is possible to obtain a little extra use by turning the wheel over and re-biting the chain.

Since the smooth surface of the sprocket wheel equipped with shear pin becomes rusty causing the shear pin not to break, it is necessary to remove the shear pin and lubricate while performing idle operation. Even if the shear pin breaking doesn't occur, if the ammeter shows an abnormal value, care is needed because the smooth surface may still be rusty. Moreover, unless a shear pin of appropriate strength is used, it may break at less than overload or not break when overload is applied.

B. Drive roller chain

The drive roller chain needs to be periodically cleaned in order to remove dust and sand, then washed with oil and greased with lubricant. When the chain becomes stretched, it is necessary to adjust the chain idler or the number of links.

C. Bearings

Machine bearings should be lubricated and inspected for abrasion at appropriate intervals. Grease is frequently used as the lubricant, however, when using a concentrated lubricating type grease pump, it is necessary to sometimes check the distributor indicator and make sure that the grease is being normally supplied.

D. Lubrication of decelerator and transmission

Always keep the oil tank of the decelerator and transmission filled with good quality lubricant. Since the viscosity of lubricant varies depending on the temperature, select a lubricant that has the specified viscosity level.

E. Guide rail

If using rack rail for the guide rail, there is no problem if there are no joints, however, if the rail does have joints or uses angle members, care is needed to prevent major accidents being caused by catches on the welded surfaces or plate screws, etc.

b) Inspection and maintenance of traveling bucket conveyor grit collector

- Outline of structure

  This has the same features as the bucket conveyor type. One unit can collect grit from multiple chambers, although the structure becomes complicated in such cases. This type is more suited to storm grit chambers, which are frequently operated at intermittent intervals.
- Inspections and maintenance

  For inspections and maintenance of the traveling bucket conveyor grit collector, see the corresponding paragraph for the bucket conveyor grit collector.

c) Inspection and maintenance of sand pump

- Outline of structure

  The jet sand pump has simple structure, is easy to maintain, has little risk of blockage by bulky solids, can conduct backwash and is resistant to burial in sediments, however, a large capacity motor is required for the pressurized water pump. Since the sand pump has mechanical parts under water and has a risk of the impeller, etc. becoming blocked with foreign materials, it loses the ability to pump sand when buried. Having said that, it requires only a relatively small motor, is relatively cheap and is suited to small-scale grit chambers.
- Inspections and maintenance

  Inspections and maintenance of the sand pump are implemented as follows.

  A. Jet sand pump

  Check for any abnormal noises, abnormal vibration and abnormal pressure during operation.

  As for inspection of the pressurized water pump, periodically check for any abnormal noises, abnormal vibration, and abnormal current and pressure during operation (see the user manual).

  Effort should be made to sustain functions of the pressurized water pump through periodically switching operation with the backup unit.

Conditions of wear and tear around the spray nozzle should be periodically inspected (around once per year).

B. Sand pump

If the impeller and liner sections of the sand pump become worn, since this diminishes the discharge flow rate and flow velocity on the discharge side, thereby making it more difficult to remove large particles and stones, etc., it is necessary to periodically replace these parts. Since the service life of the impellers differs greatly according to the level of the discharged grit chamber and the used materials, no single guide can be given. Accordingly, it I best to prescribe a rough service life based on past experience.

When using a sand pump, it is necessary to confirm safety through periodically measuring insulation resistance of the motor. When the motor insulation resistance falls, the cause should be investigated. In particular, when the waterproof seal between the pump and motor becomes worn and the motor conducting wire becomes cracked, care is needed because this will lead to water infiltration and decline in the insulation resistance.

d) Inspection and maintenance of grit collector

- Outline of structure

  The sand collecting nozzle has a simple structure, has no drive parts under water, is easy to maintain and is resistant to being buried under sediment. The screw conveyor has no parts prone to abrasion such as a submerged chain sprocket, maintenance is relatively easy and it is resistant to being buried.
- Inspections and maintenance

  Inspections and maintenance of the grit collector are implemented as follows.

  A. Sand collecting nozzle

  Check for any abnormal noises, abnormal vibration and abnormal pressure during operation. If any abnormalities are found, empty the grit chamber and confirm the spray condition of the sand collecting nozzle.

  As for inspection of the pressurized water pump, periodically check for any abnormal noises, abnormal vibration, and abnormal current and pressure during operation (see the user manual).

  Effort should be made to sustain functions of the pressurized water pump through periodically switching operation with the backup unit.

  B. Screw conveyor

  During operation, visually check the operating state of drive sections at appropriate intervals and check for any abnormalities.

  The decelerator lubricant should be replaced at periodic intervals (see the user manual).

  Visually inspect the condition of the submerged gearbox sealing water supply tank and confirm that it is operating normally. If the tank requires a lot of water replenishment, investigation is required because the gearbox sealing water may be leaking.

(5) Maintenance of pump equipment

Pumps are the primary equipment used to lift sanitary sewage and rainwater that flows into pumping stations. The main types of pump equipment are vertical shaft volute type mixed flow pump, vertical shaft mixed flow pump and screw pump, etc. The following paragraphs describe inspection and maintenance activities for these models.

a) Inspection and maintenance of vertical shaft volute type mixed flow pump

- Outline of structure

  The outline structure of the vertical shaft volute type mixed flow pump is as described below.

  ✧ The guide apparatus is in the scroll chamber; therefore, there is little chance of blockage.

  ✧ Inspections can be performed simply by removing the casing cover without having to detach the main unit casing.

  ✧ Through fully opening the suction valve, it is possible to totally separate the pump unit from the pump well.

- Inspections and maintenance

The pump structural drawings and user manuals should always be kept ready on hand in order to assist understanding of the pump structure and operating methods and to facilitate maintenance, inspections and repairs. Moreover, effort should be made to gauge the condition of each pump during normal operation and to prevent accidents through discovering abnormalities at an early point.

A. Inspections during operation

Inspections during operation can be implemented while referring to the examples shown in **Table 11-1-20**.

Table 11-1-20 Examples of Inspection Items, Contents and Intervals during Operation

Inspection Item	Inspection Contents	Inspection Interval
1. External appearance	Any abnormalities	At least once per day
2. Vibration, abnormal noise	Any abnormalities	
3. Bearing temperature	Is it room temperature +40℃ or less?	
4. Lubricating oil surface	Is it in the appropriate range?	
5. Gland heating	Is sealing water (water supply) normal?	
6. Leakage from gland packing	Is water constantly leaking in small quantities?	
7. Current during operation	Is it at the normal value?	
8. Pressure during operation	Is it normal?	

B. Inspections and maintenance

Table 11-1-21 shows examples of inspections and maintenance activities.

Table 11-1-21 Examples of Inspection and Maintenance Items, Contents and Intervals

Inspection Item	Inspection Contents	Inspection Interval
1.Bearings lubricant	Dirt, quantity	1 month
2. Gland packing abrasion	Seal leakage	
3.Replacement of bearings lubricant	Conduct when operating time is long. Replacement the first time is desirable after around 15 days.	1 year
4. Gland packing replacement	Water leakage from gland packing	
5. Bolt tightening at fixed parts	Loose bolts	
6. Operation check of protective devices such as flow relay, pressure switch and temperature switch, etc.	Operation check of each protective device	
7. Confirmation of pump and motor coupling	Loose coupling bolts	
8.Vibration in vertical shaft pump	Measurement of vertical shaft pump bearing vibration	
9. Disassembly or overhaul	Abrasion of rotating slide sections	Irregular
10. Entire instrument recoating or greasing	Rust on equipment exterior, corrosion in areas that are in contact with liquid	

b) Inspection and maintenance of vertical shaft mixed flow pump

- Outline of structure

The outline structure of the vertical shaft mixed flow pump is as described below.

✧ The pump can be fitted into a compact space.

✧ When conducting overhauls, the pump unit must be hoisted up. The guide apparatus is in the scroll chamber; therefore, there is little chance of blockage.

- Inspections and maintenance

The pump structural drawings and user manuals should always be kept ready on hand in order to assist understanding of the pump structure and operating methods and to facilitate maintenance, inspections and repairs. Moreover, effort should be made to gauge the condition of each pump during normal operation and to prevent accidents through discovering abnormalities at an early point.

A. Inspections during operation

Inspections during operation can be implemented while referring to the examples shown in **Table 11-1-20**.

B. Inspections and maintenance

Inspections and maintenance can be implemented while referring to the examples shown in **Table 11-1-21**.

c) Inspection and maintenance of screw pump

- Outline of structure

The outline structure of the screw pump is as described below.

✧ It doesn’t become blocked.
✧ There is no need to consider the shape of the pump well.
✧ Idle operation is possible.
✧ When inspecting the submerged bearings, it is necessary to empty the pump well. The guide apparatus is in the scroll chamber; therefore, there is little chance of blockage.

- Inspections and maintenance

The pump structural drawings and user manuals should always be kept ready on hand in order to assist understanding of the pump structure and operating methods and to facilitate maintenance, inspections and repairs. Moreover, effort should be made to gauge the condition of each pump during normal operation and to prevent accidents through discovering abnormalities at an early point.

A. Inspections during operation

Inspections during operation can be implemented while referring to the examples shown in **Table 11-1-22**.

Table 11-1-22 Examples of Inspection Items, Contents and Intervals during Operation

Inspection Item	Inspection Contents	Inspection Interval
1. External appearance	Any abnormalities	At least once per day
2. Vibration, abnormal noise	Any abnormalities	
3. Bearing temperature	Is it room temperature +40℃ or less?	
4. Lubricating oil surface	Is it in the appropriate range?	
5. Current during operation	Is it normal?	

B. Inspections and maintenance

Table 11-1-23 shows examples of inspections and maintenance activities.

Table 11-1-23 Examples of Inspection and Maintenance Items, Contents and Intervals

Inspection Item	Inspection Contents	Inspection Interval
1.Bearings lubricant	Dirt, quantity	1 month
2. Replacement of bearings lubricant	Conduct when operating time is long. Replacement the first time is desirable after around 15 days.	1 year
3. Bolt tightening at fixed parts	Loose bolts	
4. Operation check of protective devices such as flow relay, pressure switch and temperature switch, etc.	Operation check of each protective device	
5. Confirmation of pump and motor coupling	Loose coupling bolts	
6. Disassembly or overhaul	Abrasion of rotating slide sections	Irregular
7. Entire instrument recoating or greasing	Rust on equipment exterior, corrosion in areas that are in contact with liquid	

(6) Maintenance of pump operation control equipment

Pump operation control equipment occupies an important position among related instruments and equipment, and even partial failure of such equipment can lead to suspension of operations over the entire system. Accordingly, operators should strive to understand the overall composition and characteristics of operation control equipment, routinely conduct inspections and maintenance and strive to ensure that continuous and smooth operation is secured.

a) Inspections and maintenance

In one-man control, pump operations are started and stopped based on human discretion and it only takes a single switch to start and stop equipment including auxiliary units according to set procedures. Moreover, discharge valve openings can be operated from panels and display units are installed so that the operating conditions of various protective devices can be monitored.

In conducting operation of pumps, it is necessary to understand the composition and characteristics of control-related instruments, etc. and conduct the following kinds of inspections and maintenance.

- Routine inspections should be implemented upon referring to the examples shown in **Table 11-1-24** for details, user manuals should be referred to.

Table 11-1-24 Examples of Routine Inspection Items, Contents and Intervals

Inspection Item	Inspection Contents	Inspection Interval
1. Display lights on operating panels, control panels and monitoring panels	Check for disconnections, abnormally bright lamp checks leading to bulb blowouts	1 day ~ 1 week
2. Strange noises in control instruments	Knocking sound, smoothness, catching, different or larger sound than normal	
3. Discoloration and odor in coils	Any odor	

4. Damage of instruments	External damage, be careful of changes in surrounding conditions	
5. Room temperature	Measurement of room temperature (0～40℃)(ensure that direct sunlight doesn't fall on electronic circuits).	

- Periodic inspections should be implemented upon referring to the examples shown in **Table 11-1-25**. It is convenient to prepare inspection and maintenance item tables based on equipment user manuals, etc. Moreover, the measuring instruments, operating apparatus and spare parts required for periodic inspections should be secured.
- Since control circuits operate every time equipment is started, stopped and load is added or decreased, etc., it is immediately known when abnormalities occur. However, in the case of protective circuits, since these only operate when accidents occur, nonconforming areas often go unnoticed. Accordingly, ample inspections especially need to be implemented on protective circuits.
- Measurement of insulation resistance should be conducted separately in power circuits (high voltage and low voltage), control circuits and instrumentation circuits. Although it depends on the scale of facilities, since there are a great many circuits, it is advisable to divide the overall system into a number of blocks and to plan measurements at different times throughout the year.

Table 11-1-25 Examples of Periodic Inspection Items, Contents and Intervals

Inspection Item	Inspection Contents	Inspection Interval
1. Solenoid valves	(1) Disassemble and clean the interior. (2) Compare operating conditions before and after cleaning. (3) Check for any beating or catching	Appropriate intervals
2. Sewage-related operation valves, motor-operated valves	(1) Disassemble and clean the interior. (2) Concerning diaphragm types, look for damage to the diaphragm film. (3) In motor-operated valves, investigate corrosion and abrasion and lubricate.	
3. Limit switches	(1) Investigate the relationship between limit switch operating conditions and level of opening. (2) Investigate dirt on contacts and wipe with a cloth if dirty.	
4. Sluice valves, brakes, hydraulic switching solenoid valves	Investigate operating conditions, brake opening and closing.	
5. Liquid level meters in sewage separation tanks, makeup water tanks and oil tanks, etc.	(1) Confirm the set liquid surface. (2) Confirm operating conditions at the set liquid surface. (3) Clean each part.	
6. Pressure relays, pressure switches	(1)Check operating pressure with the set value. (2) Confirm operating conditions at the set pressure.	
7. Flow relays	(1) Confirm the set values. (2) Adjust water flow and confirm operating conditions.	
8. Temperature relays	(1) Check operating values with the set values. (2) Raise water temperature and confirm operating conditions.	
9. Over speed, low speed, designated speed relays, electric revolution indicators	(1) Check operating values with the set values. (2) Confirm operating conditions of each setting based on actual motor operation.	Irregular (1 year for the emergency backup generator equipment)
10. Terminal blocks, connectors	(1) Remove dust and make wire numbers more visible.	1 year

	(2) Confirm wiring tightening and screw looseness. (3) Check for any connector corrosion, deformation, looseness and discoloring.	
11. Timer	(1) Check settings with ledgers. (2) Measure operating times compared to set times. (3) Wipe dirty contacts with a dry cloth.	Irregular

(Note) This table assumes that city water is used for sealing water and cooling water. If shared water, treated effluent or other water that may include minute wastes is used, steps should be taken such as shortening inspection intervals and periodically cleaning the water tanks, etc.

Moreover, concerning single unit inspections, in addition to individual inspections also test protective linkage including control circuitry in order to check for circuit problems.

(7) Operation management records and their utilization

Operation management records are not simply kept and archived; they are utilized as a database for conducting analysis geared to improving future construction and maintenance. To this end, daily reports (weekly reports), monthly reports, annual reports and inspection records, etc. are prepared.

a) Forms for operation management records

The following forms are used as operation management record forms.

- Operation daily reports (weekly reports) (see **Table 11-1-26**).
- Operation monthly reports (see **Table 11-1-27**)
- Operation annual reports (see **Table 11-1-28**)
- Equipment maintenance daily reports (see **Table 11-1-29**)

b) Important points to consider

It is important to consider the following points when preparing operation management records.

(a) It is desirable to determine the recording format and unify thinking upon referring to the following examples.

- Concerning weather conditions, state in the order of change, and do not count rain if it doesn’t appear on the rain gauge.
- Concerning the peak rainfall intensity, adopt the peak rainfall over 60 minutes.
- Concerning the volume of grit and screenings, record when carrying out and check with the removal forms.
- Concerning peak electric energy, in daily reports, record as the peak hourly received power volume, while in monthly reports, record the reading from the peak supply meter with the reading from the received power meter. Check with the values cited in the power tariff bill.
- Concerning used amounts of public water supply, fuel and chemicals, check with each month’s meter readings and received slips.

(b) Concerning figures for pumped volume and used electric energy, aim to grasp overall operation management conditions and do not adopt too many digits for effective values.

(c) When adding together pumping volumes, remember that each value contains some error. For example, when adding 1,000 m3 and 10 m3, the 10 m3 often enters into the scope of error.

(d) Determine principles concerning communications and steps to take in abnormal situations.

Table 11-1-26 Example of Daily Report

Date Day Weather

Time	Pumped volume							Received power		
	Conveyed			Discharged			Total			
	Read	Disp	×10	Read	Disp	×10		Read	Disp	×10
Previous										
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
Total			m³			m³	m³			kWh

Operating condition (operating time)																											Remarks
Time		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	合計	
Grit chamber mechanical equipment	1																										
	2																										
	3																										
	4																										
	5																										
	6																										
Sewage pumps	1																										
	2																										
	3																										
	4																										
	5																										
	6																										
Rainwater pumps	1																										
	2																										
	3																										
	4																										
	5																										
Generator	1																										
	2																										
Rainfall																											
Water level m	Main line																										
	House pump																										
	Street pump																										
	Discharge																										

Daily totals				
Total			Removed	m³
Peak hourly	/h		Removed grit	m³
Temperature (13:00)	℃		30 minute peak demand	kW
Pumped volume	m³		Peak power	kWh
Breakdown	Conveye	m³	Generated	kWh
	Discharg	m³		

	Sewage pump electric power × 10						Rainwater pump electric power × 10					200V Electric energy ×1	100V Electric energy ×1	Generated	
	1	2	3	4	5	6	1	2	3	4	5			1	2
Today's reading															
Previous day's															
Disparity															
Usage	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh

Table 11-1-27 Example of Monthly Report

Date	Weather	Temperature	Total rainfall	Peak hourly rainfall	Pumped volume	Breakdown		Screenings	Removed grit	Peak power	Received power	Generated power	Total used power	Pumping power	Breakdown					Used power Per 1000 m3 of pumped volume	Date
						Sewage inflow	Other return flow								During main pump operation			200V Electric energy	100V Electric energy		
															1	2	3				
		℃		/h	m³	m³	m³	m³	m³	kW	kWh	kWh	kWh	kWh	Hr・Min	Hr・Min	Hr・Min	kWh	kWh	kWh	
1																					1
2																					2
3																					3
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27																					27
28																					28
29																					29
30																					30
31																					31
Total																					Total
Peak										( )											Peak
Minim																					Minimu
Mean																					Mean
Remarks	Note: In the peak power column brackets ( ), enter the 30-minute peak power demand.																				

Table 11-1-28 Example of Operation Annual Report

Month	Weather		Temperature	Total rainfall	Peak hourly rainfall	Pumped volume	Breakdown		Peak received power	Received power	Generated power	Total used power	Breakdown					Pump operating time				Generator operating time		Electric energy per pumped volume	Grit removal output	Screenings	
	Fine days	Rainy days					Conveyed flow	Discharge flow					Pump used power	Breakdown		200V	100V	1	2	3	4	1	2				
														Sanitary sewage	Rainwater	Electric energy	Electric energy										
	Days	Days	℃		/h	m^3	m^3	m^3	kW	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	Hour-min	Hour-min	Hour-min	Hour-min	Hour-min	Hour-min	kWh	m^3	m^3	
1																											
2																											
3																											
～																											
11																											
12																											
Total																											
Peak																											
Minimum																											
Monthly Mean																											
Monthly Mean frequency																											
Daily Peak			( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	
Daily Minimum			( )			( )	( )	( )		( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )			
Annual Daily mean																											
Annual Mean daily frequency																											
Remarks	Note: Enter the date in brackets ( ).																						Trial operating time Generator Hour-min Diesel pump Hour-min				

Table 11-1-29 Example of Equipment Maintenance Daily Report

Date (day)

Hour	Grit chamber													Pump room									Water feed pump room					Electricity room								Inspector	Hour
	Inflow gate		Front screen			Grit removing equipment			Screen					Main pump						Generator		Discharge pump	Cooling water pump		Sealing water pump	Chlorine water feed pump	Backup pump	Low voltage	High voltage panel	Special high switchgear	Special high transformer		High voltage transformer		Storage battery		
			Front screen		Accessory	Grit removing equipment		Accessory	Screen				Accessory	Pump			Motor																100V	200V			
	1	2	1	2		1	2		1	2	3	4		1	2	3	1	2	3	1	2		1	2							1	2					
1																																					1
2																																					2
3																																					3
4																																					4
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23																																					23
24																																					24
Cleaning	☐Monitoring room ☐Ante-room ☐Low voltage panel room ☐High voltage transformer room ☐Storage battery room ☐Grit chamber room ☐Pump room ☐Water feed pump room ☐Air conditioner room ☐Boiler room ☐Machine room ☐Corridor, stairs																																				

No abnormality:V Lubrication: O Repair:R Not working: X Noise: N Heating: T Abnormal ammeter reading A

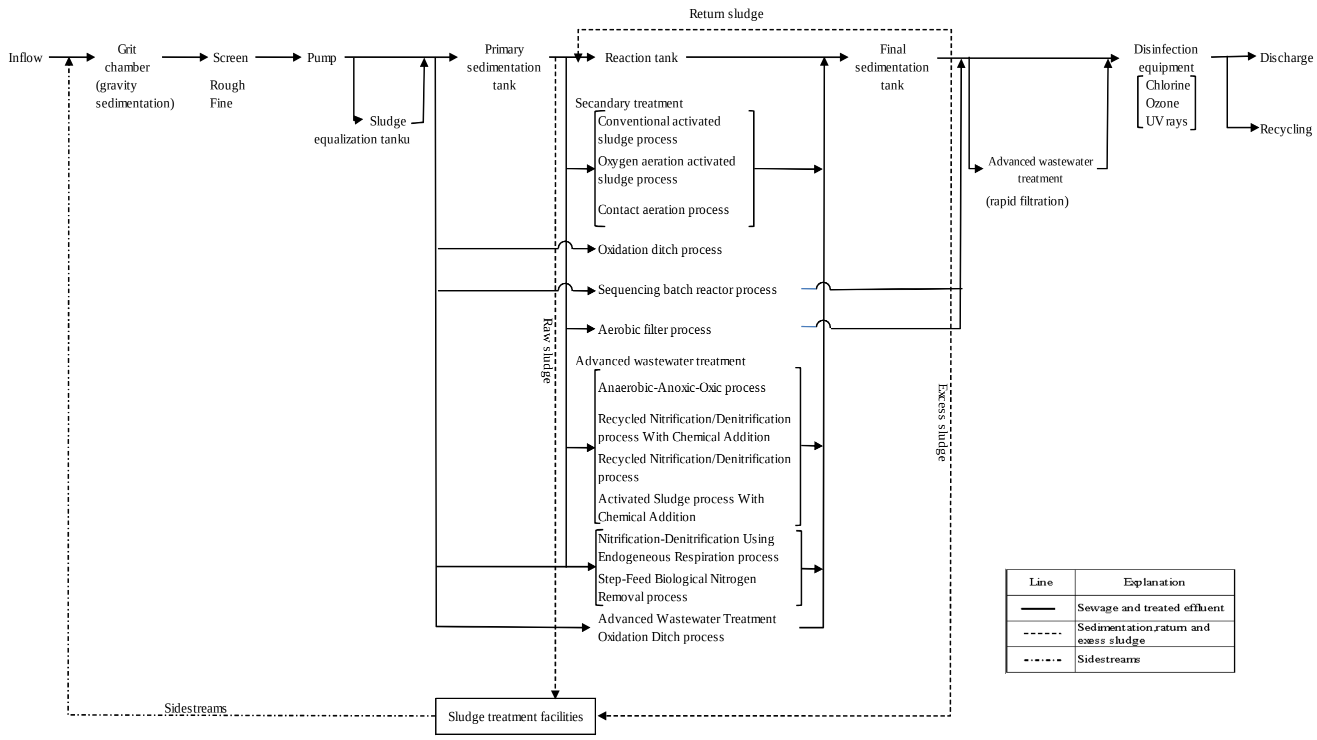
4) Maintenance of water treatment facilities

Water treatment facilities refer to treatment facilities installed as sewage system facilities for conducting final treatment of sewage and discharging it into public water bodies such as rivers and the ocean. Treatment methods in such facilities are divided into sedimentation treatment and biological treatment, which is further classified into treatment utilizing suspended microbes and treatment utilizing fixed microbes (biofilm process).

The suspended type biological treatment process entails turning the floating microorganisms in sewage into blocks (activated sludge) for decomposing organic matter. Meanwhile, the fixed type biological treatment process entails forming a biofilm on the surface of solid media and decomposing organic matter through bringing it into contact with these media.

Water treatment facilities are the general term for combinations of individual treatment facilities. The combination and arrangement of individual facilities are determined in consideration of the conditions facing each plant. **Figure 11-1-5** shows an example flow.

Figure 11-1-5 Example of Combined Flow of Water Treatment Facilities



(1) Equalization tank

a) Objective

Since the reaction tanks and final sedimentation tanks at sewage treatment plants are not designed assuming the peak hourly sewage flow, problems arise if the peak hourly incoming sewage flow greatly exceeds the daily mean sewage flow.

Generally speaking, since sewage contains high concentrations of BOD, etc. when the sewage flow is large and low concentrations when the flow is small, stable treatment cannot be conducted when the influent load fluctuates a lot.

Equalization basins are installed in order to temporarily store incoming sewage at peak times and mitigate fluctuations in the flow and quality of sewage to the treatment facilities.

Methods for adjusting the incoming flow of sewage are the inline method and the sideline method.

- Inline method:
  Since the entire incoming sewage flow passes through the basin and undergoes stirring and mixing, this can be expected to reduce the peak concentration and equalize the quality of sewage.

  Through controlling the equalization basin removal pump, the flow rate can be equalized relatively easily.
- Sideline method:
  Since only the sewage exceeding the designated level enters the equalization basin, quality equalization is not as thorough as in the inline method.

  It is necessary to control the diverted flow, discharge flow and flow time, etc., so equalizing the flow is slightly difficult.

  Equalization basins are usually equipped with aeration and stirring equipment in order to prevent sedimentation of SS and putrefaction of sewage.

b) Management of equalization basins

The following items must be appropriately managed.

- Diversion tanks
  A diversion tank is installed in the case of the sideline method. The diversion tank is intended to receive sewage conveyed by sewage pumps, divert it into the equalization basin at times of peak inflow, receive outflow from the equalization basin at times of small inflow, and thereby ensure that a uniform flow of sewage is sent to the treatment facilities.

  Diversion tanks are fitted with orifice gates for conveying uniform amounts of water to water treatment facilities and movable weirs for diverting water to the equalization tank. Moreover, for measuring the flow of water sent to the water treatment facilities, they use a weir type flow meter or electro-magnetic flow meter, etc.

  Setting of the orifice gate opening at times of fine weather is performed upon calculating the hourly mean flow from the daily inflow amount to ensure that the amount of water sent to the treatment facilities is kept constant. Moreover, since the amount of sewage inflow increases at times of rainfall, it is necessary to show care when setting the orifice gate opening.
- Mixer
  Since sewage spends a number of hours in the equalization basin, appropriate stirring and air (oxygen) supply are carried out in order to prevent sedimentation and putrefaction of sludge and generation of scum inside the basin. The mechanical aeration and diffused aeration methods, etc. are adopted for this purpose. In the case of the diffused aeration method, a disc diffuser, etc. is used for the aeration unit and a Roots blower is used as the blower, etc.

  It is desirable to conduct continuous operation of the stirring unit from the start of storage to completion of outflow while paying attention to prevention of sewage putrefaction, sludge sedimentation and scum generation.

  Moreover, although it is not usually necessary to measure DO, it is necessary to measure in cases where putrid smell is emitted from the stored sewage or when large quantities of high concentration sewage enters the basin. A DO content of around 0.5 mg/l is sufficient for preventing putrefaction of sludge.

- Runoff equipment
  A pump is used for running sewage off from the equalization basin to the water treatment facilities or diversion tank. Volute type pump and so on are used for this purpose. Moreover, since the equalization tank is subject to major fluctuations in water level and the discharge

flow varies a lot in line with changes in the pump head, control of velocity of discharge valve opening is carried out in order to convey water in a uniform flow. The amount of runoff from the equalization basin is set slightly higher than the mean daily sewage flow calculated from the daily incoming sewage volume, to en sure that the flow of sewage to the water treatment facilities is almost uniform.

c) Abnormal phenomena

If abnormal conditions arise in the following items, it is necessary to take appropriate countermeasures.

- External appearance

  Runoff water takes on blackish coloration. This is caused by putrefaction of sewage inside the equalization basin, and steps to raise the DO should be taken in order to remedy it.

  In cases where scum, foreign materials and sludge float on the surface of the basin, this should be dispersed by spraying water. Large floating objects should be removed by scooping up with a net. Moreover, because scum causes odor to occur, it needs to be dealt with as soon as it is discovered.
- Concerning pH

  The pH level sometimes drops to abnormally low levels. This frequently occurs due to putrefaction of the sewage due to inadequate stirring or aeration, and steps to raise the DO should be taken in order to remedy it. If the cause is sediment accumulation at the bottom of the basin, cleaning should be carried out.
- Others

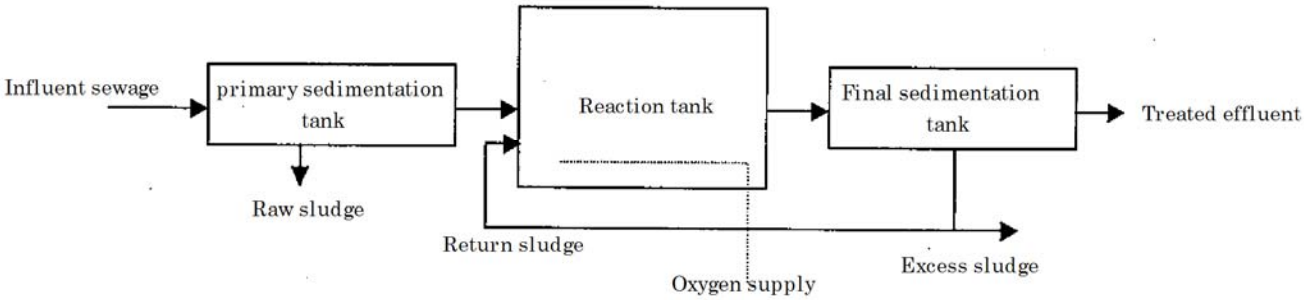
  When the SS concentration becomes abnormally high, since this can lead to sedimentation, DO shortage and putrefaction, it needs to be appropriately addressed upon investigating the return water and influent sewage.

(2) Maintenance in the conventional activated sludge process

The conventional activated sludge process is composed of the initial sedimentation tank, reaction tank and final sedimentation tank. Influent sewage passes through the initial sedimentation tank before entering the reaction tank. The conventional activated sludge process is the representative high-level treatment method for removing BOD and SS, etc. from sewage. The concentration of activated sludge suspended solids (MLSS) set in the reaction tank is maintained, while inflowing organic matter is subjected to oxidized decomposition. In the reaction tank, the oxygen required for decomposing the organic matter is supplied by means of blower or mechanical aeration. The liquid mixture from the reaction tank enters the final sedimentation tank, where solids-liquid separation takes place, and the supernatant is discharged as the treated effluent after undergoing disinfecting.

Part of the settled sludge that is separated in the final sedimentation tank is returned to the reaction tank, thereby adjusting MLSS concentration inside the tank. The activated sludge, etc., which has increased in line with the oxidized decomposition of accumulated inactive matter and organic matter, is removed as excess sludge and undergoes sludge treatment. **Figure 9-1-6** shows the flow sheet of the conventional activated sludge process.

Figure 11-1-6 Conventional Activated Sludge Process Flow Sheet



a) Inspection and maintenance of the primary sedimentation tank equipment

Mechanical and electrical equipment should be inspected in routine patrols, and such inspections should include confirmation of operating conditions in the scum collector, sludge collector, sludge weighing unit, sludge pump and automatic control device, etc. Equipment inspections should be regularly conducted at appropriate intervals according to the operating method, equipment properties and installation site, etc., and abnormal situations should be remedied as soon as they are discovered.

(a) Sludge collector

Types of sludge collector are the rotating type, chain flight type and traveling-bridge type.

- General routine maintenance inspections

  Sludge collectors should generally be handled as described below.
  - ✧ Abrasion and corrosion should always be watched for in inspections, and it is also desirable to drain basins and inspect submerged sections periodically around once per year. Moreover, worn or corroded parts should be replaced and anti-corrosive coating applied to metal parts.
  - ✧ Decelerator lubricant should be replaced and any deficiency should be supplemented around once per year.
  - ✧ Although it isn’t necessary to be very cautious during routine operation, daily patrol inspections should be implemented while paying attention to heat-generating rotating equipment, lubrication, vibration and abnormal noises, etc. of the motor, decelerator and bearings. If any abnormalities are discovered, operation should be immediately stopped and inspections implemented.
  - ✧ Since tools that drop into tanks or basins during repairs can often trigger major accidents, ample care should be displayed to make sure this doesn’t happen. If tools are dropped, they should be picked up with a powerful magnet or removed by emptying and cleaning the tank or basin concerned.
  - ✧ Tanks and basins should be cleaned when operation is suspended or basins and tanks are emptied for an extended time. At such times, since there is a risk of rust occurring in rotating parts, bearings and chains, etc., such parts should be moved slightly and lubricated or greased as necessary during weekly inspections.
- Rotating sludge collector

  Rotating sludge collectors include the central drive type and the peripheral drive type (see **Figures 11-1-7** and **11-1-8**). When conducting periodic inspections, attention should be paid to wear conditions around rotating parts and deformation of drive sections and arms, etc. Moreover, knocking during movement is sometimes caused by problems in the attached direction of wheels and so on. Sagging of the drive chain should be appropriately addressed. Moreover, the operating condition of the telescopic arm for collecting sludge from corners in square tanks should be carefully inspected.

Figure 11-1-7 Example of a Central Drive Sludge Collector

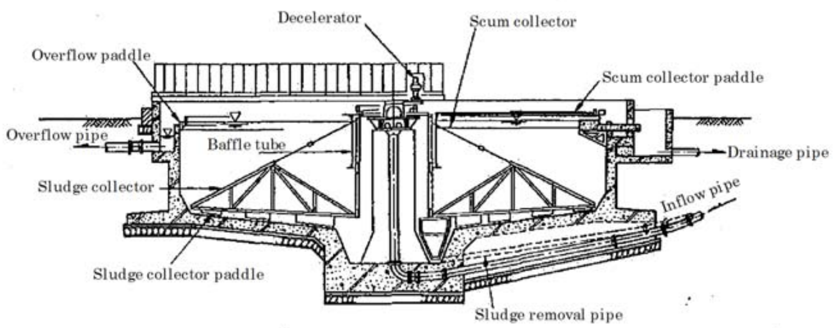
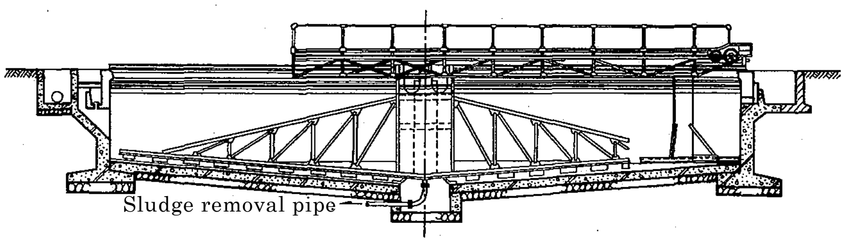


Figure 11-1-8 Example of a Peripheral Drive Sludge Collector



- Chain flight sludge collector

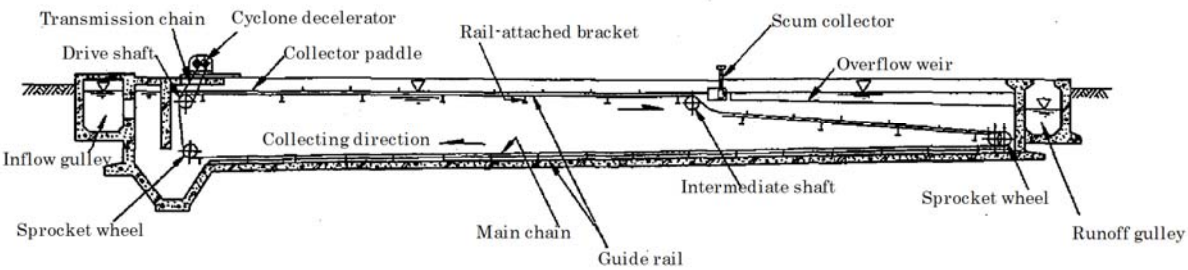
  Inspections of the chain flight sludge collector (see **Figure 11-1-9**) should be implemented as described below.

  ✧ The sludge collector paddle, shoe, chain, sprocket wheel, guide rail, lubrication pipe, joints and bolts should be checked for corrosion and looseness, etc. Any breakages should be immediately repaired on discovery.

  ✧ Investigate contact between the shoe and guide rail and bite between the chain and sprocket wheel, and adjust the chain by means of take-up. Is it necessary to replace the chain with a new one? The chain length can be adjusted to removing one or two links, however, stretching on the left r right should be guarded against, while the sludge collector paddle should be pointed in the right direction and not detach from the guide rail.

  ✧ If bearings above water or submerged are the lubricated type, grease should be replenished once per week.

Figure 11-1-9 Example of a Chain Flight Sludge Collector



(b) Sludge removal equipment

Sludge removal is carried out by the direct pumping method or by the valve operation method. In both cases, operation can be continuous or intermittent.

- Types of sludge pumps are the non-clog volute type pump, the bladeless volute type pump and the suction screw volute type pump, etc.
- Since the sludge pump can become blocked with foreign materials such as vinyl and cloth pieces, etc. in sludge, it is necessary to appropriately remove objects and conduct backwashing from the cleaning mouth.

  Routine inspections:
  - ✧ Watch out for oil leaks from the mechanical seal and gland packing shaft water sealing device and heating of seal sections.
  - ✧ Confirm that sealing water is appropriately and certainly injected.
  - ✧ Confirm that the amount of lubricant is maintained at the oil gauge indicator line.
  - ✧ Confirm that the discharge pressure reading is within the normal range.
  - ✧ Make sure there are no abnormal beats or vibration. Also pay attention to heating of the shaft section. Confirm that the machine current reading is within the normal range.

  Periodic Inspections
  - ✧ Conduct cleaning of mechanical seal and gland packing shaft water sealing device.
  - ✧ Periodically replace lubricant (for example, around once every six months).
  - ✧ If a belt is used, adjust the V-pulley centering and belt tension.
  - ✧ Conduct performance testing and confirm wear and tear of the impeller, etc. Moreover, if there is a backup unit, strive to maintain functions through periodically switching operation with the backup unit.
- Maintenance inspections according to the settled sludge removal method shall correspond to the section on the final sedimentation tank. In the initial sedimentation tank, since there are many plastic or cloth foreign materials, blockages frequently occur in pipes, valves and sludge pumps, etc. Moreover, due to the high content of sand, abrasion of the sludge pumps advances faster than in the final sedimentation tank.

(c) Scum treatment and disposal

Scum comprises a complex mixture of fibers, hairs and trash mainly consisting of oils and fats, and it sometimes expands when relatively small suspended solids attach to it. Scum is generally scraped or scooped up, dewatered by leaving or compressing and finally disposed of in the same way as screenings.

Since scum that contains a lot of oils and fats is very difficult to scoop up, suction by pump is an effective method. Moreover, in such cases, it is necessary to adjust the suction mouth. Moreover, because the sucked up scum is light and composed of minute solids, it should be disposed upon dewatering in a fine-mesh screen or belt screen.

(d) Abnormal phenomena

If the following kinds of abnormal conditions arise during operation of the primary sedimentation tank, it is necessary to take appropriate countermeasures.

- Changes in effluent water

  Abnormalities in the quality of sedimentation tank runoff water are usually manifested as changes in hue, generation of odor, decline in transparency or increase in SS, etc. Such abnormalities are either caused by, i) internal factors such as overload of return water from sludge treatment facilities, imbalance in the amount of influent to each sedimentation tank, accumulation of sludge in tanks due to insufficient sludge removal, and other structural defects, or 2) external factors such as inflow of industrial wastewater and infiltration by groundwater, river water or seawater, etc.

  To ensure the appropriate management of initial sedimentation tanks, it is important to control removal so that sludge doesn't accumulate inside tanks for a long time and to equalize the inflow to each tank. Accordingly, it is necessary to constantly gauge the sludge accumulation situation by means of a sludge threshold gauge, etc.

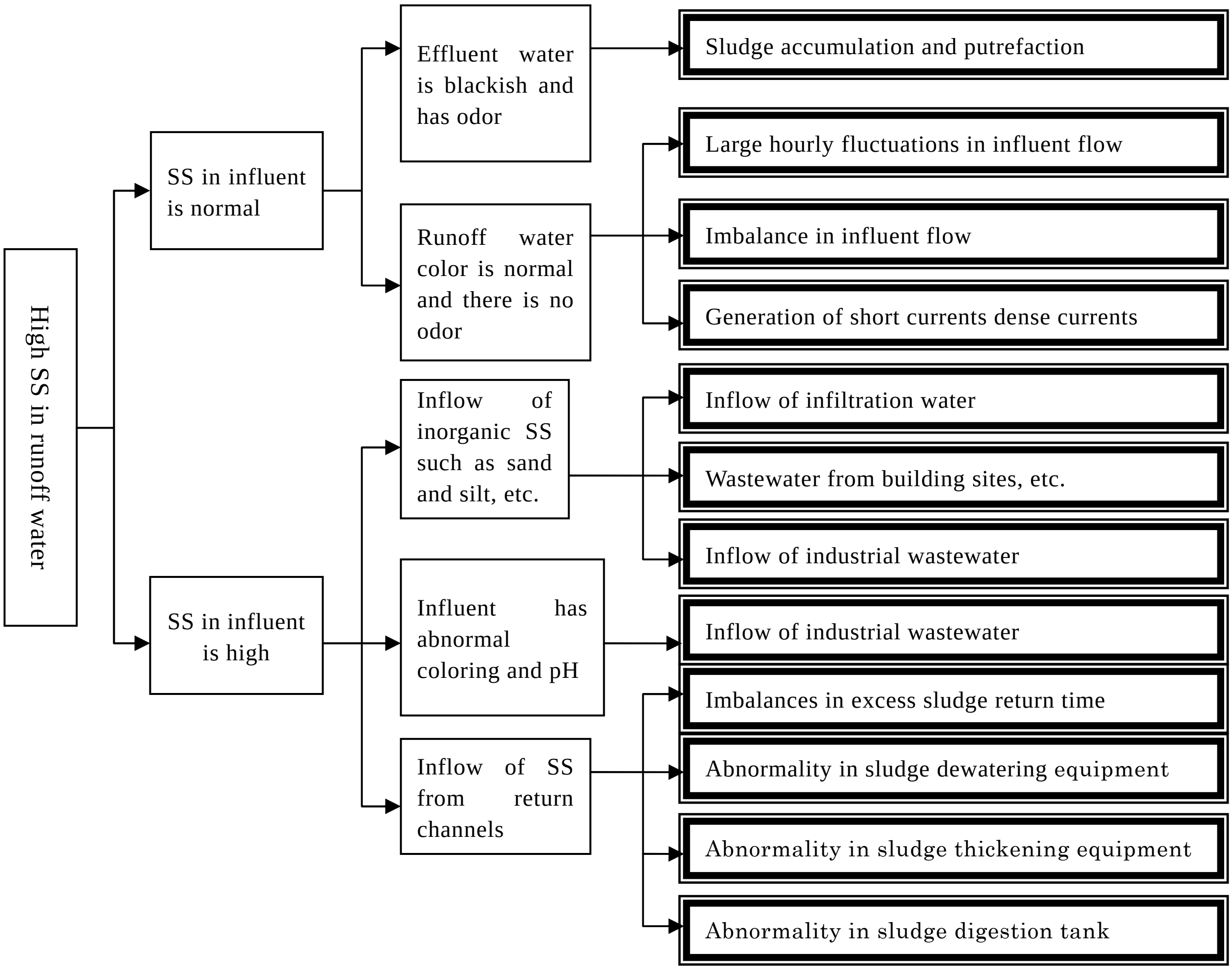
Figure 11-1-10 shows general techniques for estimating the causes of abnormalities in runoff water quality from appearance and odor, etc.

When causes of abnormality originate in operation management, appropriate steps should be taken upon referring to iv)-2 onwards. If causes lie outside of the system, effort should be made to remove them upon coordinating with related agencies, etc. Moreover, it is necessary to make improvements in cases where problems originate out of the structure of tanks, etc.

- Changes in tank water level
  - ✧ In cases where abnormalities are caused by inflow of putrefied sewage, it is necessary to adjust operation of the sewage pump and carry out brushing, etc. to ensure that such sewage is not retained in conduit facilities for too long.
  - ✧ If abnormalities originate out of industrial wastewater, it is necessary to adjust the quality of the said wastewater.
  - ✧ In cases where abnormalities arise when large amounts of separated liquid containing a lot of SS from sludge thickening tanks is returned, the amount of sludge being removed should be temporarily reduced in order to mitigate the load in sludge treatment.
  - ✧ In cases where abnormalities arise out of separated liquid from the sludge digestion tank, the position for removing separated liquid should be reviewed and the operating method of the sludge digestion tank improved.
- Flotation caused by putrefaction of sludge
  - ✧ If the sedimentation time becomes too long, removal is inappropriate or sludge is left to accumulate for too long, it putrefies and floats to the surface. Since the first sign of this is the appearance of large amounts of foam on the water surface, the removed amount of sludge should be increased when this occurs. Moreover, since problems in the sludge collector can also cause this problem, the sludge collector should be inspected to make sure that the chain isn’t broken or the machine isn’t operating idly.
  - ✧ When sludge floats to the surface, it should either be removed by scum skimmer or net or broken up with pressurized water. Alternatively, it can be removed by overflowing the floating sludge into the reaction tank. In this case, since the volume of activated sludge increases, it is necessary to increase the removed quantity of excess sludge.
- Runoff of sludge from the overflow weir

  Since deterioration in water quality is usually recognized before the runoff of sludge, this must be immediately addressed in order to prevent sludge runoff. However, in cases where the influent flow increases dramatically and abnormality is caused by excessive water area load or overflow load at the weir, the sewage pump should be adjusted in order to minimize fluctuations in influent flow, and the length of the overflow weir should be increased. Moreover, it is better to return water from the thickening and dewatering processes and separated liquid from the sludge digestion tank at times when the influent load is low. In cases where abnormalities arise from excessive accumulation of sludge, the removed amount of sludge should be increased.

Figure 11-1-10 Example of Procedure for Estimating Causes of Abnormality



b) Inspection and maintenance of reaction tank equipment

The reaction tank is a facility that biological treats organic matter in sewage and, together with the final sedimentation tank, is one of the most important water treatment facilities in the sewage treatment plant.

In the reaction tank, through supplying oxygen in air to a mixture of sewage and activated sludge mainly comprising microbes (including bacteria and protozoans, etc.) that feed on the organic matter of sewage, the microbes decompose the organic matter while consuming the dissolved oxygen.

Accordingly, sewage treatment by the activated sludge method proceeds according to the appropriate concentration of microbes, concentration of dissolved oxygen and retention time in the reaction tank. Accordingly, in addition to checking the quantity and quality of sewage flowing into the reaction tank, it is necessary to monitor MLDO and MLSS, etc. and adjust the quantity of blown air, returned sludge and excess sludge.

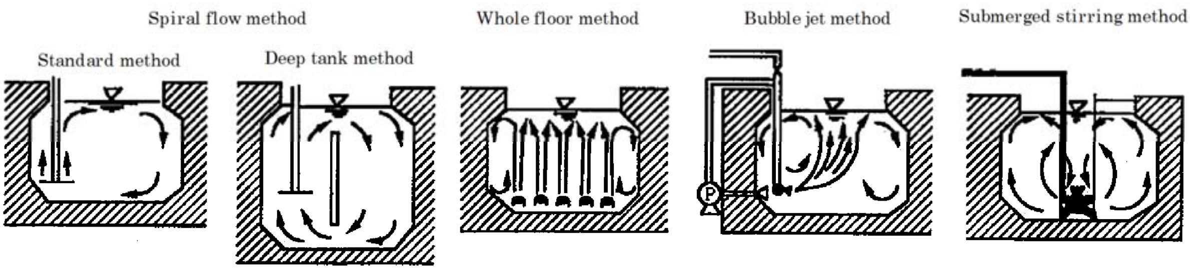
It is necessary to sustain stable treatment in the reaction tank through carrying out routine maintenance inspections and periodic maintenance inspections of the air diffuser, foaming equipment and sludge return equipment.

(a) Air diffuser

The air diffuser supplies the necessary amount of oxygen and carries out adequate stirring with respect to the mixture of influent sewage and return sludge in the reaction tank.

- Aeration method
  Different types of aeration method are spiral flow aeration, whole floor aeration, micro-bubble jet aeration and submerged stirring, etc. (see **Figure 11-1-11**).

Figure 11-1-11 Types of Aeration System



- Air diffuser
  Structure of the air diffuser differs according to the size of air bubbles and position of installation, etc. Also, there are fixed and moving types depending on the method of installation. Generally, fixed air diffusers are more common, however, movable air diffusers have the advantage of being able to receive inspections and replacements without suspending operation.
- Air diffuser breakdowns
  Most breakdowns in air diffusers are caused by blockage, and this is especially common in perforated air diffusers used with micro-bubbles. In these micro-bubble perforated air diffusers, passing air resistance is said to increase by around 50 mmAq every year, although this differs according to the conditions of use.

  Blockages from the inside are caused by particles and dust in the air used for diffusion, sludge that flows backwards when air supply is stopped, rusting and oil content inside pipes and so on. In order to remove particles and dust from the supplied air, it is necessary to conduct ample purification using an air filter. Moreover, waste materials inside pipes should be blasted out when replacing the pipes. Externally caused blockages arise as a result of sludge, sand, oil, trash, iron and bacteria, etc. inside tanks, and such blockages are accelerated by backflows caused by stoppage of air supply. In micro-bubble air diffusers, since blockages occur more quickly in cases where the air flow per unit area is too small, it is also important to examine the quantity of air diffusers based on the standard air flow.
  Air diffusers are generally replaced with new units when blockage reaches a certain stage. In cases of recycling air diffusers and using them again, ceramic types should be re-fired, oxidized, surface polished and backwashed, while synthetic resin types should be oxidized and backwashed. When conducting oxidation treatment, thought must be given to treatment of waste liquid.

(b) Foam prevention equipment

Foam prevention equipment consists of the following sprinkler systems, foam prevention net and foam prevention covers, etc.

- Sprinkler system
  The sprinkler system is a system for dispersing surface foam by sprinkling jet water through a nozzle in order to prevent excessive foaming on the water surface in tanks, discharge pipes and conveyance pipes, etc. The nozzle is made from anti-corrosive metal such as cast iron, gun metal or stainless steel or synthetic resin, and a structure whereby jet water hits the water surface in a fan shape is generally adopted.

  Since the foam dissipating effect differs according to the nozzle structure, attachment intervals and positions, jet angle, water pressure and water flow, etc., the ideal state should be obtained through adjusting these elements. Treated effluent is often used for deforming, however, because this contains microscopic wastes and algae, etc. that can cause the nozzle to become blocked if used for a long time, it is necessary to implement inspections and cleaning. Depending on the attached position of the nozzle, since work is frequently conducted facing into the water channel, ample care should be taken to avoid falling in.

- Anti-foaming net

  Anti-foaming nets are installed in order to limit generation of foam in tanks, discharge pipes and conveyance pipes, etc. and prevent foam from leaving the plant.

  Since the anti-foaming net tends to easily become corroded by foam, it is best to use a vinyl-covered wire net or a net with mesh made from nylon or saran, etc. If the anti-foaming net becomes damaged or the support fittings become corroded, they should be repaired immediately.

- Anti-foaming cover

  A recently adopted approach is to cover tanks with a plate, etc. made from synthetic resin in order to prevent odor and foaming inside tanks.

(c) Sludge return equipment

Sludge pumps are usually used in order to return sludge, and the types used for this purpose include the non-clogging volute type pump, bladeless volute type pump, volute type pump with suction screw and so on. Pump inspections should be conducted as was described in the section on initial sedimentation tank.

Methods for controlling the flow of sludge include controlling the operating numb of sludge return pumps, controlling revolutions and controlling valves, etc. Controlling the number of operating units is a simple method, however, because this doesn’t allow fine adjustments, it is often combined with other approaches.

Control of the number of revolutions can be done by the power supply frequency control method or the eddy current joint method, etc. In cases where the number of revolutions is reduced, efficiency declines but not as much as in the case of valve control, etc. Since the rotator efficiency characteristics of the control device differ according to the method, this method should be combined with controlling the number of units in order to utilize the efficiency characteristics in operation.

Valve control is a method for adjusting the flow of return sludge through controlling the opening of control valves on pipe routes, and this can either be performed by automatic valves or manual valves. In the case of manual valves, since the sludge flow differs due to clogging by foreign materials, it is always necessary to conduct monitoring with a flow meter. Since valve control entails adjusting the sludge flow through tightening valves and imparting a loss, it is not very efficient.

(d) Abnormal phenomena

Abnormalities in the reaction tank are often manifested in the SV and SVI of MLDO, test results for biota as well as abnormal conditions in appearance and odor, etc. during routine patrol inspections. Since abnormalities in the reaction tank take longer to recover from if they become more advanced, it is necessary to take countermeasures as soon as abnormal conditions are discovered. If problems originate in the quality of influent sewage, it becomes necessary to take steps to normalize industrial wastewater, etc.

- Abnormalities in properties, appearance and odor of activated sludge

  Abnormalities in properties, appearance and odor of activated sludge inside the reaction tank include the following things.

  ✧ Discoloration of activated sludge

  Normal activated sludge changes from a yellow-brown color to brown, foam starts to appear on the surface of the reaction tank, and a lightly moldy smell is generated. The main items and causes of abnormalities in appearance and odor are as follows.

Black discoloration of activated sludge: This is caused by accumulation of sulfides, accumulation of manganese oxide and inflow of industrial wastewater, etc.

Orange discoloration of activated sludge: This is almost always caused by the large-scale infiltration of influent with high iron content.

✧ Abnormal foaming

This is mainly caused by two things, i.e. surface-active agent or antinomies (ray fungus) and its related bacteria.

Foaming caused by surface-active agent

Foaming caused by antinomies (ray fungus) and its related bacteria

✧ Bulking of activated sludge

SVI (sludge volume index) is used as an indicator of activated sludge settling and compaction characteristics. The SVI of normal state activated sludge is around 100~200, however, the phenomena where SVI dramatically increases above its normal level is generally called bulking. Bulking describes the situation where activated sludge and supernatant cannot be fully separated due to excessive decline in the settling and compression characteristics of the activated sludge. In such cases, the supernatant becomes extremely clear in appearance. Once activated sludge becomes bulky, since this causes the sludge-liquid interface in the final sedimentation tank to rise to close to the water surface, large amounts of activated sludge flow out.

There are two types of bulking, i.e. viscous bulking (zoo glare bulking), in which the flocs of activated sludge expand, and filiform bulking, where the settling and compaction properties of activated sludge decline due to the preponderance of filarial microbes in the activated sludge.

✧ Flotation and breakup of activated sludge

Flotation of activated sludge

In the final sedimentation tank, some of the activated sludge floats to the surface without sinking, while sludge that sank once sometimes floats to the surface again. These phenomena are called flotation of activated sludge. This has two causes as described below. One is the attachment of floc to air bubbles, and ray fungus is a typical example of this. The other cause is flotation arising from nitrogen gas generated in the denitrification reaction. A similar phenomenon is observed when settled sludge is disturbed by gases (carbon dioxide, hydrogen sulfide, etc.) generated in the anaerobic reaction.

c) Inspection and maintenance of blower equipment

In addition to maintaining blowers through everyday maintenance inspections, the required air flow must be adjusted in order to maintain stable treatment.

Blowers consist of centrifugal blowers and volumetric rotary blowers, and accessory equipment is used to operate these devices smoothly. Moreover, on the suction side of blowers, air filters are fitted as accessory equipment in order to prevent abrasion of impellers and clogging of air diffusers due to airborne dust, particles and oil, etc.

The discharged air is sent to the reaction tank, etc. through pipes, and since the power consumption of blowers accounts for a major portion of power use in the entire treatment plant, effort should be made to ensure efficient operation of them.

(a) Types of blower

Centrifugal blowers are divided into multi-stage turbo blowers and single-stage accelerating blowers. As for volumetric rotary blowers, these boost air pressure by rotary motion of a rotor, and they are divided into the Roots blower and rotary blower.

(b) Inspection management

Inspections of blowers should be implemented while referring to the examples indicated in **Tables 11-1-30** and **11-1-31**.

When conducting operation management, staff should thoroughly understand the purpose of installation, specifications and characteristics, etc. and never continue operating with an abnormal situation left unattended. Moreover, in cases where there is a backup blower, operation should be switched to ensure that the backup unit is not left idle for too long. When stopping operation after a long time, bearings should be appropriately lubricated. In particular, if the motor is a wound motor, the slip ring should be carefully maintained and care taken to prevent attachment by dust and rust.

Table 11-1-30 shows examples of the items, contents and intervals of routine inspections.

Table 11-1-30 Examples of Routine Inspection Items, Contents and Intervals

Inspection Item	Inspection Contents	Interval
Bearing temperature (blowers, motors, accelerators)	Check that temperature is normal and record it with current, voltage and room temperature.	1 day
Casing temperature (suction, discharge)	Check that it is in the normal range and record together with suction and discharge pressure and degree of opening of suction valve.	
Bearings vibration	Check that it is in the normal range and record.	
Internal acoustics (bearings, casing, motors)	Remember and compare the internal acoustics of each part at normal times.	
Lubrication (oil leaks, oil level)	Inspect by means of oil pressure gauge, flow site and oil surface gauge, etc.	
Liquid level in main oil tank	Check that it is within the reference level range.	1 week
Oil cooler	Record temperature (water temperature, oil temperature) at the inlet, outlet. Visual checking by flow sight.	
Oil filter clogging	Record the inlet and outlet pressure.	
Dry air filter	Watch the pressure loss of filter materials in the dry air filter. Visually check dirt on the filter materials.	1 month
Oil pump (vibration)	Inspect by feeling, and measure and record by vibration meter according to necessity. Confirm with a listening rod.	
Cooling water pump (vibration)	Inspect by feeling, and measure and record by vibration meter according to necessity. Confirm with a listening rod.	
Electric-oil operating instruments (Vibration) (Internal acoustics) (Oil leakage)	Inspect by feeling, and measure and record by vibration meter according to necessity. Confirm with a listening rod. Visually check for oil leaks.	

Table 11-1-31 Examples of Periodic Inspection Items, Contents and Intervals

Inspection Item	Inspection Contents	Interval
Wet air filter	Sludge removal from washing oil	
Auxiliary unit motor Discharge motor-driven valve Lubrication motor-driven valve Motor-driven butterfly valve Startup controller Others	Measure insulation resistance (targeting backup units that haven't been used for a long time, units with short operating time and units that don't always operate).	6 months or 1 year
Bearings	Judge contact from luster of the bearings metal. Measure scratch gaps to investigate abrasion.	5 years
Rotating parts	Wipe off dust and examine damage and corrosion, etc. Check for loose rivets by hammering. Examine loose fixing nuts.	
Casing inner surfaces	Look for contact scratches, foreign materials and corrosion in the labyrinth. Examine dust conditions and coating peeling, etc.	
Coupling	Examine damage in each part.	
Rubber cushion	Examine fatigue and cracked rubber.	
Foundation bolts	Examine looseness by hammering.	
Motor bearings	Same as with blower bearings	
Motor Brush Slip ring Shorting contact	State of slip ring (abrasion) Brush abrasion Attachment of brush holder Surface of shorting contacts	

d) Inspection and maintenance of final sedimentation tank equipment

The final sedimentation tank receives liquid mixture runoff from the reaction tank, separates the activated sludge by sedimentation in order to obtain clear treated effluent, and returns the settled sludge once more to the reaction tank. Sludge settling performance in the sedimentation tank is greatly affected by hourly changes in influent flow, changes in sludge settling properties, MLSS concentration and water temperature, etc., however, it is necessary to maintain SS concentration at the stipulated level in the reaction tank and prevent sludge from running off from the sedimentation tank through collecting the settled sludge and returning it. To ensure appropriate operation of the treatment plant, it is necessary to gauge the plant treatment characteristics from routine operation.

Final sedimentation tanks are available in square shape, rectangular shape and circular shape, and the direction of flow is divided into parallel flow, radial flow and vertical flow according to the structure of the tank. Moreover, the flow direction and flow velocity inside the tank differ according to area, and they also vary according to changes in the amount of water entering the tank.

Usually, the entire tank is used, and it is rare for parts of tanks to the kept idle in order to adjust the sedimentation time. Even in cases where the influent flow is small compared to design water flow, unlike initial sedimentation tanks and reaction tanks, problems rarely occur due to the sedimentation time being too long.

(a) Maintenance inspection of final sedimentation tank equipment

It is necessary to conduct routine and periodic inspections on the following items and to reflect the findings in normal operation management.

- Sludge collector
  See the section on the primary sedimentation tank.
- Sludge removal equipment
  See the section on the primary sedimentation tank.

(b) Maintenance of overflow weir and scum removal

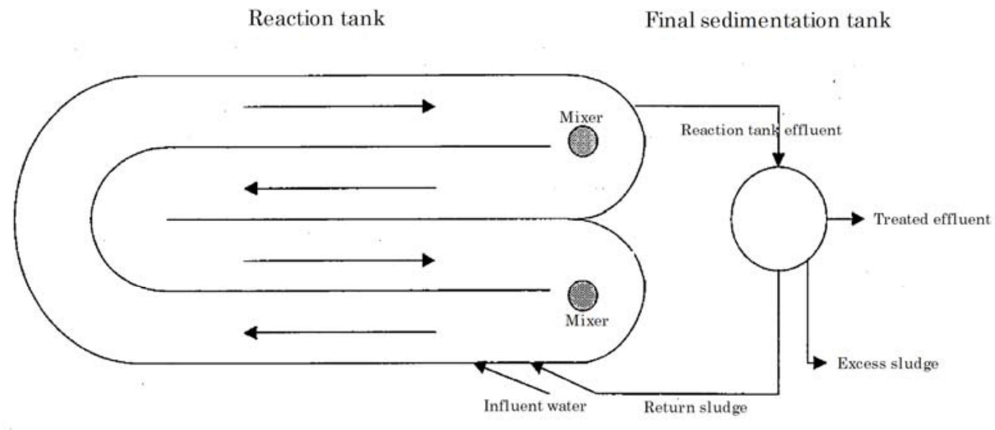
Cleaning and inspections should be implemented to ensure that the overflow weir and scum collector fully display their functions.

Management of the overflow weir is the same as described for the initial sedimentation tank, however, because overflow water from the final sedimentation tank generally becomes the final treated effluent, the floating scum, activated sludge and algae, etc. around the overflow weir give a bad appearance and cause the overflow to become imbalanced, so it is desirable to conduct regular cleaning. If the tank is covered, sunlight is kept out and photosynthesis is impeded, making it difficult for algae to grow. Growth of algae can also be checked by coating the tank around the tank edge with special coating or applying copper plate. Also, scum and algae collected in cleaning should be prevented from escaping through catching in fine mesh netting on runoff pipes, etc. When there is uneven settlement, since the overflow becomes imbalanced, thereby causing uneven influent flow and drift to occur, this has a major impact on the sedimentation tank functions. To counter this, the weir level should be measured and corrected.

(4) Maintenance in the oxidation ditch process

In the oxidation ditch method, an unending channel is used as a reaction tank conducting low-load activated sludge treatment, while solids-liquid separation is carried out in the final sedimentation tank. As a rule the initial sedimentation tank is not installed. A mechanical aeration unit supplies the necessary oxygen for treatment, mixes influent water with activated sludge inside the reaction tank, and imparts flow velocity to the liquid mixture to prevent the activated sludge from settling. When using a blower in order to supply oxygen, a mixer for imparting flow speed is used in tandem. **Figure 11-1-12** shows the flow sheet of the oxidation ditch method. Since retention time in this method is long at more than 24 hours, fluctuations in water quality and temperature only have a minor impact on treated effluent, thereby making this method conducive to stable treatment.

Figure 11-1-12 Treatment Flow in the Oxidation Ditch Process



a) Maintenance inspection of reaction tank equipment

It is necessary to appropriately manage the stirring and aeration equipment at normal times and to take countermeasures at times of breakdown.

(a) Mixer

Figure 11-1-13 shows the mixing and aeration equipment that is adopted in the oxidation ditch method.

- Vertical rotary mixer
  The vertical rotors are rotated on the surface of the reaction tank in order to create a flow in the channel and at the same time supply oxygen through mixing. Rotors fitted with a number of blades are frequently used in order to carry out the mixing (stirring). The mixer is composed of rotors, drive shaft and motor, etc. and has simple structure because it doesn't require blower equipment. Moreover, operation management is relatively simple (see **Figure 11-1-14**).
- Horizontal shaft type mixer
  The horizontal shaft type mixer users horizontal shaft rotors to stir the surface of the reaction tank, while at the same time conducting aeration by imparting flow velocity and circulating water in the channel. Since this method generally conducts mixing at a number of places in the reaction tank, it enables efficient mixing and makes it easy to secure the DO concentration gradient. Moreover, the mixer structure is relatively simple. However, as in the aeration method, since air cannot always be supplied at high volume, this type is frequently adopted in the oxidation ditch process where water depth is relatively shallow and surface area is large.

  As in the vertical shaft method, operation management is relatively simple. Moreover, sludge fly-off and noise can be addressed through placing a cover over the mixing section. In this case, it is necessary to consider how to respond to water level fluctuations and odor inside the tank.

(b) Management and maintenance inspections of reaction tank equipment
- Maintenance at normal times
  The reaction tank equipment is maintained as follows at normal times.
  ✧ Since foreign materials on the rotor blades can impede air-liquid mixing and reduce the aeration effect, they should be removed.
  ✧ Lubricate and grease the decelerator bearings, etc. according to the instructions given in the user manual.

- ✧ In mechanisms where a single motor and single rotary shaft are used to operate multiple mixers, care needs to be shown concerning vibration of the rotary axis, otherwise this could cause the rotary axis bearings to break.
- ✧ Since activated sludge tends to stick to the tank walls and the overflow section, this should be periodically removed since it is dangerous for work.

- Response to breakdowns

  Since the mixer has a small number of rotations and simple structure, breakdowns are rare provided that lubrication is properly conducted, however, in cases where strange noise occurs during starting and stopping, the shaft joints should be inspected. Moreover, if there is vibration during operation, the fixed mechanism of the mixer should be checked for any loose screws or damage to the bearings.

Figure 11-1-13 Types of Mixing and Aeration Equipment

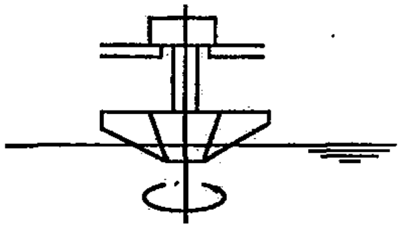
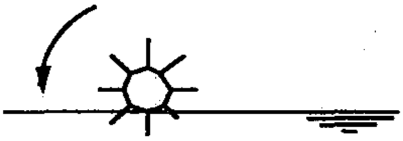
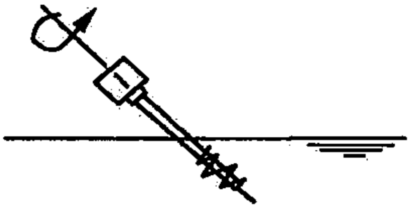
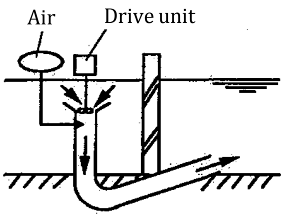
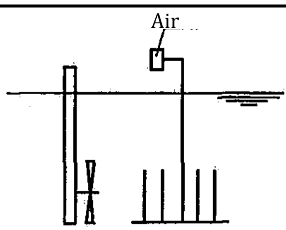
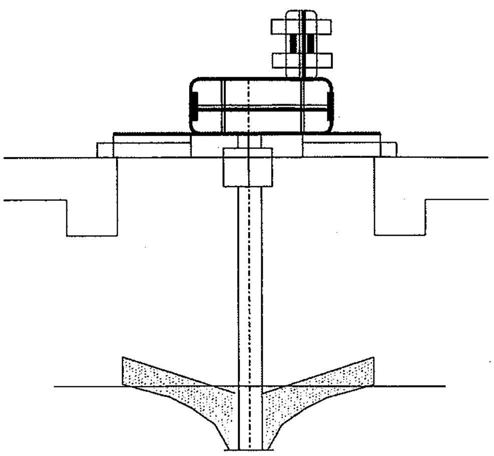
Type	Outline	
Vertical shaft		This is a surface aeration approach in which the rotary force of the drive section is transmitted to the impeller immersed in the water.
Horizontal shaft		This is a surface aeration approach in which rotors with blades attached to the horizontal rotary shaft mix the surface of the water.
Screw type		This is a submerged aeration approach in which negative pressure created by screw rotation is utilized to supply air and diffuse it through the water as micro-bubbles.
Axial flow pump type		This type combines axial flow impeller mixing with air suction from the diffused air pipe, and the air-liquid mixture is blasted from the tank bottom by an axial flow pump.
propeller type		In this method, mixing and stirring are carried out by submerged propeller, while oxygen is supplied by an air diffuser plate.

Figure 11-1-14 Vertical Shaft rotary Mixer



(c) Abnormal phenomena

If any of the following abnormalities arise, they must be appropriately addressed.

- ✧ Discoloration of activated sludge
- ✧ Abnormal foaming
- ✧ Bulking of activated sludge
- ✧ Flotation and breakup of activated sludge
- ✧ Abnormal conditions in the biota
- ✧ Decline in organic matter removal functions
- ✧ Decline in coliform bacteria removal functions
- ✧ Increase in treated effluent BOD due to digestion

Abnormalities in the reaction tank are often manifested in the SV, MLDO, sludge bulking and test results for biota as well as abnormal conditions in appearance and odor, etc. during routine patrol inspections. Since abnormalities in the reaction tank take longer to recover from if they become more advanced, it is necessary to take countermeasures as soon as abnormal conditions are discovered. If problems originate in the quality of influent sewage, it is necessary to take steps to normalize industrial wastewater, etc.

b) Maintenance inspections of final sedimentation tank equipment

The final sedimentation tank receives liquid mixture runoff from the reaction tank, separates the activated sludge by sedimentation in order to obtain clear treated effluent, and returns the settled sludge once more to the reaction tank. Sludge settling performance in the sedimentation tank is greatly affected by hourly changes in influent flow, changes in sludge settling properties, MLSS concentration and water temperature, etc., however, it is necessary to maintain the MLSS concentration at a uniform level and prevent sludge from running off through collecting the settled sludge and returning it. To ensure appropriate operation of the treatment plant, it is necessary to gauge the plant treatment characteristics from routine operation.

The final sedimentation tank as a rule is circular in shape and uses the radial flow system, since this enables easy maintenance of the sludge collector and is economical.

(a) Maintenance inspections of the final sedimentation tank

It is necessary to implement routine and periodic inspections on the following items and to reflect the results in normal operation management.

- Sludge collector
  If the collector speed is too fast, this impedes the settlement of sludge, while if it is too slow, the sludge will putrefy and float to the surface. A sludge collector with adjustable speed should be adjusted to the speed that enables the best quality treated effluent to be obtained based on experience. If a fixed-speed sludge collector is used and the collecting speed is inappropriate, it is necessary to reexamine the deceleration ratio.
- Sludge removal equipment
  In tank operation management, it is important for the accumulate sludge to be continuously removed in stable fashion. For this reason, it is necessary to conduct appropriate operation management of the sludge removal valve and pump, etc.
- Overflow weir and scum collector
  Floating scum, activated sludge, algae and generated plant matter etc. floating or attaching around the overflow weir give a bad appearance and cause the overflow to become imbalanced, so it is desirable to conduct regular cleaning. Since algae do not grow so much in covered tanks, this feature should be utilized. Alternatively, growth of algae can be checked by coating the tank around the tank edge with special coating or applying copper plate. Also, scum and algae collected in cleaning should be prevented from escaping through catching in fine mesh netting on runoff pipes, etc.
  When there is uneven settlement, since the overflow becomes imbalanced, thereby causing uneven influent flow and drift to occur, this has a major impact on the sedimentation tank

functions. To counter this, the weir level should be measured and corrected.
Since there is no initial sedimentation tank in the oxidation ditch method, it is necessary to install a scum collector.

(b) Abnormal phenomena

If any of the following abnormalities arise, they must be appropriately addressed.

- ✧ Changes in runoff effluent
- ✧ Flotation of sludge
- ✧ Sludge runoff from the overflow weir

Abnormalities in the final sedimentation tank are often manifested in the test results for SV, COD and SS, etc. and can also be observed as abnormal appearance during routine inspections.

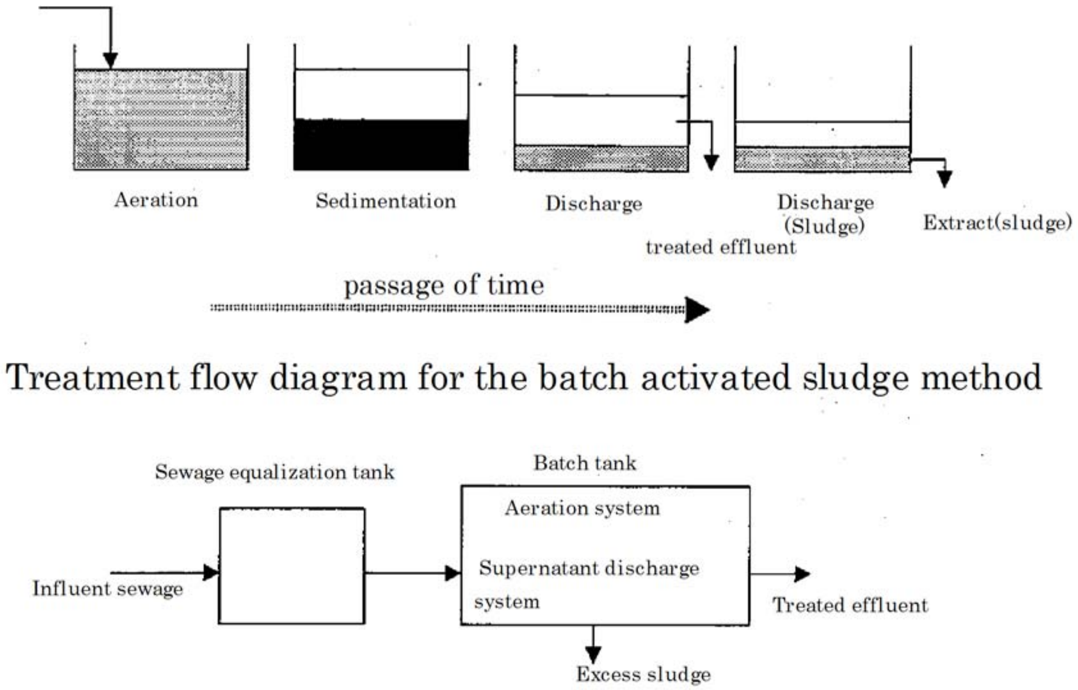
Such abnormalities are frequently caused by inappropriate accumulation of sludge or removal of excess sludge, structural defects in tanks, and other final sedimentation tank causes such as short currents and dense currents, etc., as well as problems in the influent sewage and reaction tank. Accordingly, it is necessary to consider tank maintenance in tandem with the reaction tank. Moreover, since tank abnormalities immediately impact the quality of discharge effluent from the treatment plant, it is necessary to immediately deal with them as soon as abnormalities or signs of abnormalities are detected.

(5) Maintenance in the sequencing batch reactor process

In the sequencing batch reactor process, a single batch tank is given reaction tank and final sedimentation tank functions and the following processes are repeated, i.e. treatment of influent sewage using activated sludge, liquid mixture precipitation, supernatant removal, and sludge removal. As a rule, no initial sedimentation tank is installed in this process. Moreover, since this is a batch method, since it is prone to the effects of fluctuations in the incoming sewage flow, a sludge equalization tank is often installed. **Figure 11-1-15** shows the process flow.

In the batch activated sludge method, the batch tank is endowed with the functions of a reaction tank fitted with aeration equipment and a final sedimentation tank for discharging treated effluent and sludge. The batch activated sludge method can be operated either as a high-load process adopting the same organic load as in the standard activated sludge method, or as a low-load process with the same load as in the oxidation ditch process. Through performing intermittent operation, it is possible to remove nitrogen in low-load operation and phosphorous in high-load operation.

Figure 11-1-15 Treatment Flow in the Sequencing Batch Reactor Process



(a) Maintenance inspections of the batch tank equipment

Appropriate routine maintenance must be carried out on the following equipment.

✧ Air diffusion and mixing equipment

✧ Treated effluent discharge equipment and scum collector

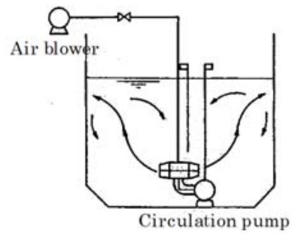
- Air diffusion and mixing equipment

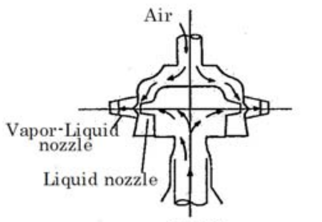
  In the sequencing batch reactor process, since there is no initial sedimentation tank and oxygen supply is based on on/off operation, equipment that is resistant to clogging and can perform ample mixing is selected. However, it is necessary to make sure that the air diffusion and mixing equipment can operate stably by confirming air flow, pressure, revolutions, current, DO and treated effluent quality in routine inspection. **Figure 11-1-16** shows a comparison of characteristics in air diffusion and mixing equipment.

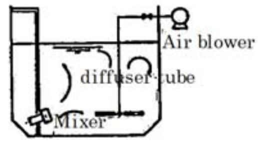
- Treated effluent discharge equipment and scum collector

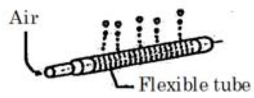
  The discharge equipment is designed to remove e supernatant that is separated from the activated sludge in the sedimentation process and it has a mechanism that can discharge in line with fluctuations in the water level accompanying the supernatant discharge. It is necessary to conduct routine inspections and maintenance to ensure that this mechanism operates correctly. Moreover, since scum is apt to occur in the batch activated sludge method, the scum collector should undergo proper maintenance to prevent decline of functions due to clogging, etc. **Figure 11-1-17** shows the outline of the float treated effluent discharge system.

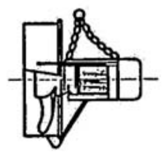
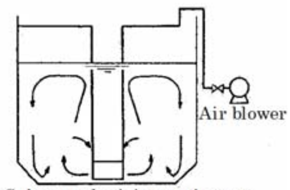
Figure 11-1-16 Comparison of Characteristics of Air Diffusion and Mixing Equipment

<table>
<tr><th></th><th>Micro-bubble jet system</th><th>Air diffuser + mixer</th><th>Submerged mixing</th></tr>
<tr><td>Structure</td>
<td>

Overall block diagram


diffuser part section detail drawing</td>
<td>

Overall block diagram


diffuser tube
+

Mixer</td>
<td>

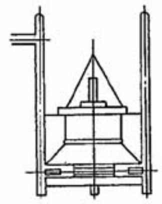
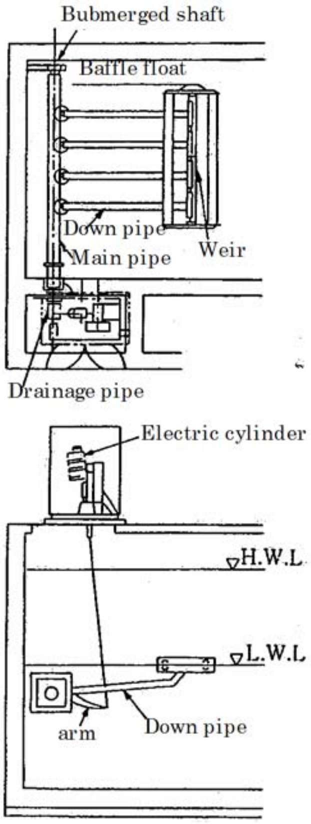
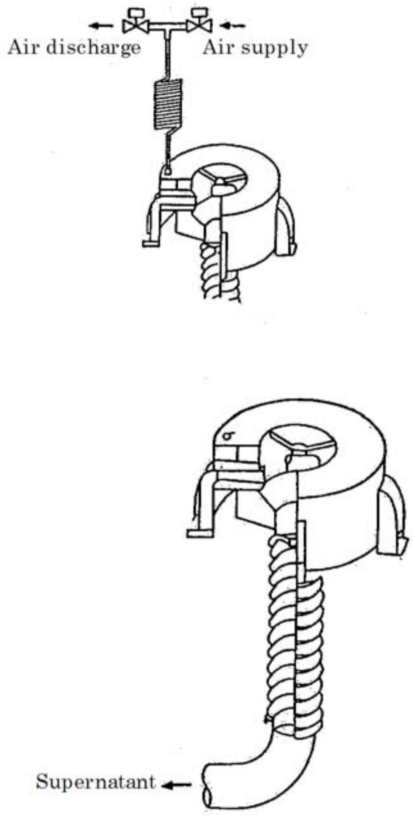
Submerged mixing equipment
Overall block diagram

Section detail drawing</td></tr>
<tr><td>Outline</td>
<td>Liquid mixture in the tank is circulated by pump, air is finely dispersed by that energy, and this raises the oxygen transfer efficiency. During mixing, blasting and movement around the tank, velocity or friction of the liquid and gas causes shearing force at the air-liquid interface. This causes oxygen transfer and air-liquid renewal and also draws in and mixes liquid in the nearby area.</td>
<td>Air supply is carried out by air diffuser tube (flexible tube). In cases of anoxic operation, mixing is conducted separately by a submerged mixer.
Incidentally, the aeration flexible tube has slits so that it doesn't clog even when performing on-off operation.</td>
<td>Liquid mixture in the tank is mechanically mixed, while supplied air is crushed, thereby raising the oxygen transfer efficiency and power efficiency.
A submerged air diffuser performs mixing and aeration around a single shaft and is installed at the bottom of the tank.</td></tr>
</table>

Figure11-1-17 Outline of the Float Type Treated Effluent Discharge Equipment

	Float arm type (motor-driven cylinder)	Float guide type
Structure		
Outline	The equipment comprises a float, wear pipe, submerged shaft drainage pipe and cylinder. It follows up fluctuations in water level through rotation of the submerged bearings. The water colleting wear pipe is enclosed by baffle floats preventing inflow of scum. During the aeration process, equipment is raised above the water by the cylinder.	The equipment comprises float, telescopic drainage pipe and guide. The water collection mouth is a submerged pipe that prevents infiltration by scum. During the aeration process, air is sent to the buoyancy control chamber to boost buoyancy, while the water collection inlet is submerged and drainage is stopped.

(b) Abnormal phenomena

Treatment functions in the batch activated sludge method decline if substances that impede microbial activity infiltrate the system or there is change in the environmental conditions. Moreover, in cases where solids-liquid separation cannot be adequately conducted in the sedimentation process, sludge runs off with treated effluent and reduces the effluent quality and it becomes impossible to sustain the necessary MLSS concentration.

If any of the following abnormalities arise, they must be appropriately addressed.

- Activated sludge properties and appearance and Abnormal odor
  - ✧ Discoloration of activated sludge
  - ✧ Abnormal foaming
  - ✧ Bulking of activated sludge
  - ✧ Flotation and breakup of activated sludge
  - ✧ Abnormal conditions in the biota
- Decline in treatment performance
  - ✧ Decline in organic matter removal functions
  - ✧ Decline in coliform bacteria removal functions

✧ Increase in treated effluent BOD due to digestion

Abnormalities in the batch tank are frequently manifested in the MLDO, sludge settlement volume, sludge bulking and test results for biota as well as abnormal conditions in appearance and odor, etc. during routine patrol inspections. Since abnormalities in the batch tank take longer to recover from if they become more advanced, it is necessary to take countermeasures as soon as abnormal conditions are discovered. If problems originate in the quality of influent sewage, it is necessary to take steps to normalize industrial wastewater, etc.

(6) Operation management records and their utilization

The objective behind preparing operation management records is to determine whether or not operation is being conducted as planned and, in cases where conditions are not as expected (either better or worse), to provide data for compiling new realistic plans.

Operation management records are useful for preparing manuals suited to each treatment plant, and they make it possible to aim for more stable and efficient operation with better effluent quality, etc.

Records also provide important data for rebuilding, upgrading and extending facilities.

a) Preparation of operation management records

It is important to consider the following points when preparing operation management records.

✧ Types of records
✧ Important consideration points

It is important to prepare inspection record formats that comply with these objectives. Bearing in mind that taking records incurs costs, it is a good idea to arrange recording items and conduct periodic reviews while also considering efficiency.

(a) Types of records

Records are broadly divided into records concerning the operation management of facilities, records concerning repairs and maintenance, records that are required by law, and records that are needed for reports.

Tables 11-1-32 and **11-1-33** show the types and contents of records concerned with maintenance inspections and operation. Moreover, **Tables 11-1-34 through 11-1-39** show examples of operation management records.

- Maintenance inspection records

Table 11-1-32 Types and Contents of Maintenance Inspection Records

Type	Contents
Maintenance inspection daily log	This is a detailed record stating inspection results for each inspection item of each equipment on site. Contents including items to pass on, etc. are entered on-site.
Maintenance inspection daily report	Based on the maintenance inspection daily log, this states the summary of the inspection results, items of special note and judgments concerning the results, etc.
Periodic inspection record	Periodic inspection records that are implemented every month, 3 months, 6 months or year according to the inspection criteria.

-

- Operation records

Table 11-1-33 Types and Contents of Operation Records

Type	Contents
Operation daily log	Based on instrumentation display data in the monitoring room or on-site, this records each day's operating conditions and performance and includes the following basic items: ① Treatment performance ② Items directed linked to operating cost such as electric power and chemicals, etc. ③ Compulsory items concerning legal regulations, etc. ④ Operating condition of main facilities and equipment
Operation daily report	This is used for grasping and reporting daily operating conditions. It is a summary of main items based on the operation daily log.
Operation monthly report / annual report	In order to provide data for planning improvements to operating methods and facilities and equipment, monthly reports are prepared by summarizing the daily reports, while annual reports are prepared by summarizing the monthly reports.

- Examples of operation management records
  - ✧ Operation daily reports – Indoor treatment facilities maintenance (see **Table 11-1-34,35)**
  - ✧ Operation daily reports – Operating times (see **Table 11-1-36)**
  - ✧ Operation monthly reports (see **Table 11-1-37,38**)
  - ✧ Operation annual reports (see **Table 11-1-39**)

(b) Important points to consider

It is important to consider the following points when preparing operation management records.

- It is desirable to determine the recording format and unify thinking upon referring to the following examples.
  - ✧ Concerning weather conditions, state in the order of change, and do not count rain if it doesn’t appear on the rain gauge.
  - ✧ Concerning the peak rainfall intensity, adopt the peak rainfall over 60 minutes.
  - ✧ Prescribe effective numerical values so that they are 2~3 digits.
  - ✧ Concerning the volume of grit and screenings, record when carrying out and check with the removal forms.
  - ✧ Concerning peak electric energy, in daily reports, record as the peak hourly received power volume, while in monthly reports, record the reading from the peak supply meter with the reading from the received power meter. Check with the values cited in the power tariff bill.
  - ✧ Concerning used amounts of public water supply, fuel and chemicals, check with each month’s meter readings and received slips.
- Concerning figures for water flow, sludge volume and used electric energy, aim to grasp overall operation management conditions and do not adopt too many digits for effective values.
- When adding together water flow an sludge volumes, remember that each value contains some error.

b) Utilization of operation records

It is important for the recorder to understand the purpose of each item on the record sheet and to make accurate entries while making on-site judgments.

In keeping records, it is of course necessary to determine whether or not each inspection result is normal. At this time an effective means of quickly discovering abnormalities is to consider normal or abnormal conditions in terms of the overall flow of the entire treatment system and to crosscheck different records. Moreover, it is important to understand whom to contact and what steps to take in the event where abnormal conditions are found.

Due to recent technological advances and the trend towards labor saving, operation management data loggers have been introduced to many treatment plants and pumping stations. Moreover, operation management record formats are made easy to understand and compatible for use with data loggers.

c) Archiving of operation management records

Operation management records should be archived by methods that ensure easy use when needed and prevent scattering and loss.

If operation methods, instrumentation systems and measurement positions, etc. are frequently changed due to works, repairs and periodic inspections, etc., data will lose its continuity. Apart from cases where continuity is secured through correcting data, each data must be treated as a separate type. It is necessary to not only record such revisions in daily reports and monthly reports but also to prepare lists and record them in monthly reports and annual reports to ensure that erroneous conclusions are not derived later on.

Since data concerning quantities and quality are mutually used by related departments, it is desirable to utilize convenient data basing and spreadsheet software. Because treatment facilities operate as a mutually related single plant, rather than managing according to each facility, it is desirable to manage the data from each all together. However, raw data should not be confused with processed data.

Table 11-1-34 Example of operation daily report - Indoor treatment facilities maintenance (1)

Date　　Day　　Weather

Teme	Sedimentation tank room													Pump room									Blower room										Water supply pump room					Air filter room Ai filter		Electricity room								Inspector	Teme
	Inflow gate		Front screen			Grit removal equipment			Screen					Main pump						Generator		Drainage pump	Blower						Blower distribution panel	Air flow control panel	Lubricant pump	Drainage pump	Cooling water pump		Sealing water pump	Chlorine water feed pump	Backup pump			Low voltage panel	High voltage panel		Special high voltage transformer		High voltage transformer		Storage battery		
			Front screen		Accessory equipment	Grit removal equipme		Accessory equipment	Screen				Accessory equipment	Pump			Motor						Blower			Motor																			V	V			
	1	2	1	2		1	2		1	2	3	4		1	2	3	1	2	3	1	2		1	2	3	1	2	3					1	2				1	2				1	2					
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No abnormality:V　Lubrication: O　Repair: R　Not working: X　Noise: N　Heating: T　Abnormal ammeter reading A

Table 11-1-35　Example of operation daily report - Outdoor treatment facilities maintenance (2)

Date　　Day　　Weather

Time	Primary sedimentation tank										Reaction tank						Final sedimentation tank											Chlorine room		Pipe gallery					Inspector	Time
	Collector						Removed sludge pump room				Air flow						Collector						Removed sludge pump room					Chlorine storage room	Chlorine dosing room	Drainage pump			Excess activated sludge pump			
	1		2		3		Distribution panel	Sludge pump			1		2		3		1		2		3		Distribution panel	High voltage transformer	Sludge pump											
	1	2	1	2	1	2		1	2	3	1	2	1	2	1	2	1	2	1	2	1	2			1	2	3			1	2	3	1	2		
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24																																				24
Remarks																																				

No abnormality:V　Lubrication: O　Repair: R　Not working: X　Noise: N　Heating: T　Abnormal ammeter reading A

Table 11-1-36 Example of operation daily reports - Operating times

Date Day Weather

Facility			Time	Operating conditions																								Operating time (h/m)	Remarks
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Grit chamber	1	Water passage																										/	
		Front screen																										/	
		Collector																										/	
		Screen	1																									/	
			2																									/	
	2	Water passage																										/	
		Front screen																										/	
		Collector																										/	
		Screen	1																									/	
			2																									/	
Main pump	1																											/	
	2																											/	
	3																											/	
Generator	1																											/	
	2																											/	
Preliminary aeration tank	1																											/	
	2																											/	
Primary sedimentation tank	1	Water passage																										/	
	2	Water passage																										/	
	3	Water passage																										/	
	Sludge pump		1																									/	
			2																									/	
			3																									/	
Reaction tank	1	Water passage																										/	
	2	Water passage																										/	
	3	Water passage																										/	
Blower	1																											/	
	2																											/	
	3																											/	
Final sedimentation tank	1	Water passage																										/	
	2	Water passage																										/	
	3	Water passage																										/	
	Sludge pump		1																									/	
			2																									/	
			3																									/	

Table 11-1-37 Example of operation monthly report (1)

Date	Weather	Temperature	Total rainfall	Pak hourly rainfall	Pumped volume	Breakdown		Amount of screening	Removed amount of sediments	Peak power	Received power	Generated power	Total power usage	Pumping electric energy	Breakdown					Electricity used per 1000 m^3 of pumped water	Electricity used in water treatment	Breakdown					Electricity used per 1000 m^3 of treated	Electricity used in sewage treatment	Date
						Influent sewage flow	Other return water flow								Main pump operating time			V electric energy	V electric energy			Blower	Blower operating time			Return sludge pump room			
															1	2	3						1	2	3				
		℃	mm	mm/H	m^3	m^3	m^3	m^3	m^3	kWh	kWh	kWh	kWh	kWh	h/m	h/m	h/m	kWh	kWh	kWh	kWh	kWh	h/m	h/m	h/m	kWh	kWh	kWh	
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31																													31
Total																													Total
Peak										( )																			Peak
Minimum																													Minimum
Mean																													Mean
Remarks	Note: Enter the 30-minute peak power demand for peak power.																												

Table 11-1-38 Example of operation monthly report (2)

Date	Water temperature	Preliminary aeration tank				Primary sedimentation tank			Disinfecting equipment (basic treated effluent)				Reaction tank				Final sedimentation tank			Disinfecting equipment (treated effluent)				Date
		Influent flow	Air flow	Air flow per 1 m^3 of influent	Reaction time	Influent flow	Sedimentation time	Removed sludge volume	Basic treated effluent flow	Dosage	Dosing rate	Dosing time	Influent flow	Air flow	Air flow per 1 m^3 of influent flow	Reaction time	Sedimentation time	Return sludge volume	Excess sludge volume	Treated effluent flow	Dosage	Dosing rate	Dosing time	
	℃	m^3	m^3	m^3	h/m	m^3	h/m	m^3	m^3	kg	mg/l	h/m	m^3	m^3	m^3	h/m	h/m	m^3	m^3	m^3	kg	mg/l	h/m	
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Total																								Total
Peak																								Peak
Minimum																								Minimum
Mean																								Mean
Remarks																								

Table 11-1-39 Example of operation annual report

Month	Weather		Temperature	Total rainfall	Peak hourly rainfall	Pumped volume	Breakdown		30-minute peak power	Received power	Generated power	Total used power	Breakdown					Pump operating time				Generator operating time		Electric power per 1000 m^3 of pumped water	Grit removal output	Removed screenings	Month
	Fine days	Rainy days					Conveyed	Discharged					Pump used power	Breakdown: Sewage	Breakdown: Rainwater	V electric energy	V electric energy	1	2		11	1	2				
	d	d	℃	mm	mm/H	m^3	m^3	m^3	kW	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	h/m	h/m		h/m	h/m	h/m	kWh	m^3	m^3	
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Total																											Total
Peak																											Peak
Minimum																											Minimum
Month: Mean																											Mean (Month)
Month: Mean frequency																											Mean frequency (Month)
Day: Peak			( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	Peak (Day)
Day: Minimum			( )			( )	( )	( )		( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )	( )			Minimum (Day)
Annual: Daily mean																											Daily mean (Annual)
Annual: Mean daily frequency																											Mean daily frequency (Annual)
Remarks	Trial operating time Generator: hours minutes Diesel pump: hours minutes Note: Enter the date in brackets ( ).																										

5) Maintenance of sludge treatment facilities

Sewage treatment not only involves the purification of sewage in water treatment facilities, but the treatment is only completed when sludge separated in the water treatment is removed from the sludge treatment facilities and recycled or disposed. Moreover, management of sewage treatment and management of sludge treatment are interrelated. In other words, poor management of water treatment causes efficiency to drop in sludge treatment, while poor management of sludge treatment causes sludge to enter the water treatment system and cause effluent quality to deteriorate. Accordingly, it is necessary for each department to communicate and cooperate in order to ensure the overall operation management of the entire treatment plant.

Sludge treatment is conducted through various combinations of thickening, digestion, dewatering and effective utilization. Operation management in each process has been described in the respective sections on each, however, to sum up the role of sludge treatment, it is intended to promptly treat the entire separated sludge load so that it can be easily handled and removed before it putrefies and to contribute to the properties that will make it useful for recycling.

(1) Maintenance of sludge thickening equipment

a) Role of sludge thickening equipment

(a) Volume reduction of sludge

The function of sludge thickening equipment is to thicken sludge that is generated in water treatment facilities with a low concentration of solids, and thereby contribute to the effective functioning of later stage sludge digestion tank and sludge dewatering equipment. Since this equipment increases the solid concentration of sludge and reduces its volume by means of solids-liquid separation, if the sludge thickening process is not appropriate, not only will this reducing treatment efficiency in the sludge digestion and dewatering processes, but it will also impart a negative impact on water treatment and lead to deterioration of treated effluent quality.

(b) Volume adjustment of sludge through temporary storage

The amount of sludge generated in water treatment facilities is subject to hourly and seasonal fluctuations. If gravity thickening is adopted in the thickening equipment, stable operation can be ensured in later sludge treatment facilities though temporarily storing and adjusting the quantity of sludge. However, since sludge putrefies easily, it is necessary to treat quickly and any adjustment should not exceed the scope at which putrefaction occurs.

b) Types of sludge

(a) Initial sedimentation tank sludge

Out of the different types of sludge, that sludge generated in the initial sedimentation tank is most conducive to sedimentation and thickening, however, the amount of sludge generated fluctuates greatly. Particularly in combined sewer systems, the amount of sludge generated increases. Accordingly, gravity thickening, which is more suited to dealing with flow fluctuations, is appropriate in such cases.

However, depending on the treatment plant, excess sludge is sometimes inserted into the initial sedimentation tank, and this hinders thickening characteristics somewhat.

(b) Excess sludge

The excess sludge generated in the final sedimentation tank displays the most stability in terms of generated quantity, however, its thickening characteristics are not as good as those of initial sedimentation tank sludge.

c) Thickening method

Sludge thickening methods are broadly divided into gravity thickening, centrifugal thickening and flotation thickening, etc. Since the thickening effect in each method is impacted by the properties of the sludge, in order to carry out efficient sludge thickening, it is necessary to conduct appropriate water quality management that includes gauging the properties of inserted sludge.

d) Inspection and maintenance of gravity thickening equipment

In the gravity thickening tank, sludge is held and thickened by utilizing natural gravity, and the thickened sludge that gathers at the bottom is removed by sludge collector. This system is composed of the following equipment. Incidentally, the tank shape is usually round.

- Tank body (generally the tank body is made from reinforced concrete and is equipped with an overflow weir and scum discharge pipe).
- Sludge collector (drive unit, sludge collection plate, scum collection plate, picket fence)
- Sludge insertion pipe and removal pipe

When conducting the inspection and maintenance of this equipment, it is advisable to prescribe inspection frequency according to the contents of each item and to conduct inspections according to check lists and inspection record sheets, etc.

- Routine inspections

  Routine inspections, which involve patrolling equipment and confirming current operating conditions by visual check and simple inspections, are important for maintaining the functions of equipment. The major inspection items are as follows:

  A. Motor and decelerator: Check for strange noise, vibration and abnormal bearings temperature.
  B. Check the drive chain tension, abrasion and lubrication.
  C. Make sure that the lubricant surface of the decelerator is at the oil gauge indicator line and that lubricant is not leaking.
  D. Confirm ammeter readings and operation display lamps, etc. on local panels, etc.

E. Make sure that the scum collector is operating normally.

F. If there is a sludge-liquid interface gauge, make sure that operation of the cable drum (upward motion of sensor) is normal.

G. It is advisable to inspect the overflow weir and runoff channel and remove any scum that has attached. If the tank is covered, the inspection cover must be opened in order to check inside, however, ample care needs to be shown regarding hydrogen sulfide gas when doing so.

- Periodic inspections

Periodic inspections are implemented in order to check the functions of equipment according to the inspection points and contents. The main inspection items are as follows.

A. Periodically replace lubricant (for example, once every 6 months).

B. In order to inspect submerged parts, it is advisable to empty the tank and inspect/measure equipment corrosion, abrasion and deformation. Moreover, since corrosive gases can cause the tank to deteriorate in the case of covered tanks, it is necessary to inspect concrete corrosion and anti-corrosive coating inside the tank. Moreover, care is required when inspecting inside tanks because there is risk of oxygen deficiency.

C. Operative protective devices to make sure that they are functioning in unison.

D. If there is a sludge-liquid interface gauge, wash away scale, etc. from the sensor in order to prevent wrong operation.

E. If deodorization is conducted, check the duct conditions and air suction flow, etc.

e) Inspection and maintenance of centrifugal thickening equipment

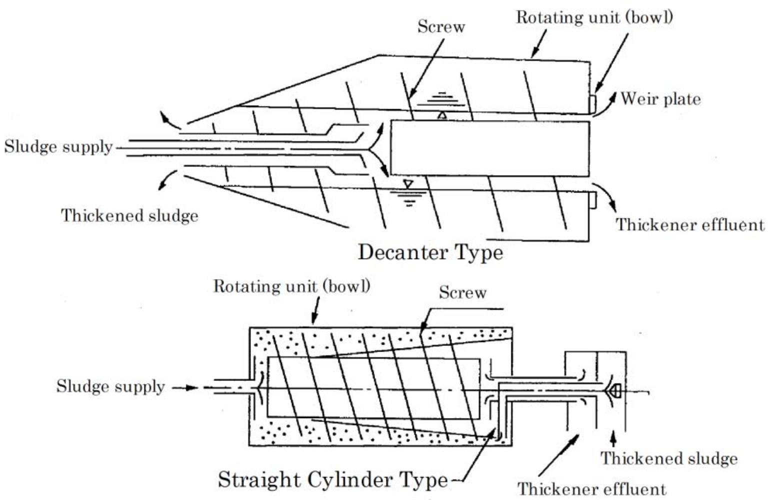
Through conducting solids-liquid separation of sludge in a high centrifugal force field, the centrifugal thickener can mechanically thicken excess sludge that is not conducive to gravity thickening. There are two types of centrifugal thickening equipment, i.e. the horizontal type (screw type) and the vertical type (basket type).

Since the vertical type centrifugal thickener is hardly used at all in recent times, the horizontal type is described here.

The discharge side of the horizontal centrifugal thickener is shaped like a cone. There are two types: one is the decanter type, in which the screw scrapes thickened sludge along the sloping part and continuously discharges it, and the other is the straight cylindrical type, in which the rotating bowl is cylindrical and thickened sludge is continuously discharged from the discharge nozzle (see **Figure 11-1-18**).

A screen is installed in front of the centrifugal thickener in order to prevent blockage (clogging) of the internal mechanism.

Figure 11-1-18 Horizontal Centrifugal Thickeners



When conducting the inspection and maintenance of this equipment, it is advisable to follow check lists and inspection record sheets, etc. that have been established beforehand for each equipment.

- Routine inspections
  A. Main bearings and decelerator: Check the lubricant level and the state of grease on internal bearings.
  B. Inspect temperature around rotating parts such as bearings, etc.
  C. Check for abnormal vibration in the thickener and motor.
  D. Check the current value of the motor.
  E. Check the rotating differential (differential speed) and centrifugal force.
  F. Confirm the concentration of the thickened sludge solids and SS of separated liquid.
- Periodic inspections
  Periodic inspections are implemented in order to check the functions of equipment according to the inspection points and contents. The main inspection items are as follows.
  A. Wear and tear around the sludge outlet of the thickener
  B. Operating state of safety devices
  C. Check for looseness or damage in the V-belt.
  D. Measure abrasion in the screw and tip (it is advisable to keep records in order to gauge the abrasion status according to operation time).
  E. Check for blockage of the sludge and chemical feed pipes.

f) Inspection and maintenance of dispersed –air floatation thickening equipment

The dispersed –air floatation thickening method entails attaching micro-bubbles to sludge particles, thereby reducing the sludge apparent specific gravity in relation to water to fall and causing it to float to the surface. This method is mainly used for thickening excess sludge.

In order to generate micro-bubbles, the commonly adopted method is to release pressurized water and dissolved air (under hundreds of kPa) under atmospheric pressure.

Methods for bringing sludge into contact with air bubbles include pressurized mixing, in which pressurized water and sludge are mixed and then depressurized to generate bubbles, and depressurized mixing, in which pressurized water is depressurized and air bubbles are created before being mixed with sludge (see **Figure 11-1-19**).

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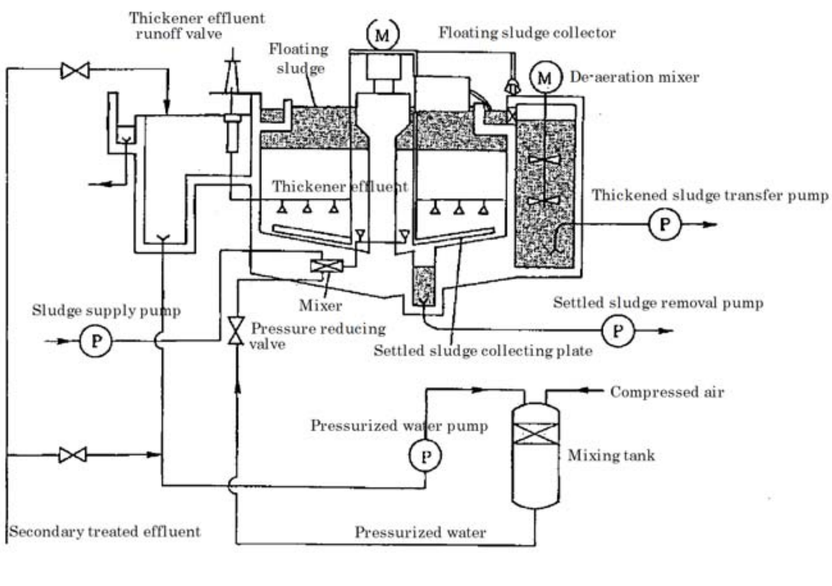
Figure 11-1-19 Flow of the Dispersed –Air Floatation Tank



When conducting the inspection and maintenance of this equipment, it is advisable to follow check lists and inspection record sheets, etc. that have been established beforehand for each equipment.

- Routine inspections

  Routine inspections, which involve patrolling equipment and confirming current operating conditions by visual check and simple inspections, are important for maintaining the functions of equipment. The major inspection items are as follows:

  A. Motor and decelerator: Check for strange noise, vibration and abnormal bearings temperature.

  B. Make sure that the lubricant surface of the decelerator is at the oil gauge indicator line and that lubricant is not leaking.

  C. Confirm ammeter readings and operation display lamps, etc. on local panels, etc.

- Periodic inspections

  Periodic inspections are implemented in order to check the functions of equipment according to the inspection points and contents. The main inspection items are as follows:

  A. Periodically replace lubricant (for example, once every 6 months).

  B. In order to inspect submerged parts, it is advisable to empty the tank and inspect/measure equipment corrosion, abrasion and deformation. Moreover, since corrosive gases can cause the tank to deteriorate in the case of covered tanks, it is necessary to check this aspect too.

  C. Operative protective devices to make sure that they are functioning in unison.

  D. If deodorization is conducted, check the duct conditions and air suction flow, etc.

g) Inspection and maintenance of atmospheric pressure flotation thickening

Utilizing the fact that the surface of solids in sewage sludge is negatively charged, the atmospheric pressure flotation thickening entails adding agent (foaming agent or high polymer coagulant) in order to electrochemically adsorb air bubbles with sludge solids. This method allows the sludge solids concentration to be easily adjusted over the range of around 3~7% and has the feature of keeping the solids recovery rate steady irrespective of the properties of inserted sludge.

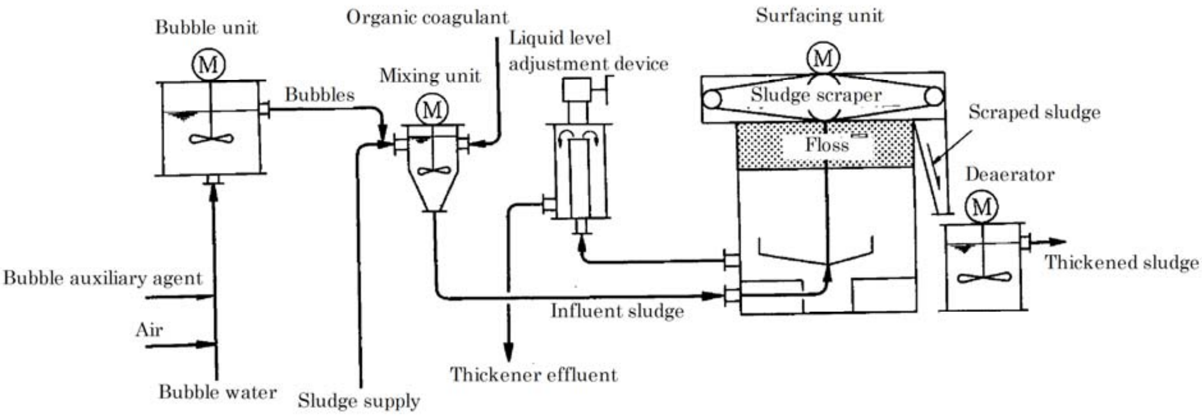
In this method, air and liquid dosed with foaming agent are mixed in order to generate micro-bubbles, and the bubbles are adsorbed to solids in sludge by using high polymer coagulant. As a result, the apparent specific gravity of solids falls to 1 or less, causing the sludge solids to float to the surface. This method is used for thickening initial sedimentation tank sludge, excess sludge and mixed sludge.

The atmospheric pressure flotation thickening system is composed of the following equipment.

- Foaming unit: This unit mixes air and liquid dosed with foaming agent are mixed in order to generate micro-bubbles.
- Mixing unit: This mixes micro-bubbles, sludge and high-polymer coagulant in order to attach the bubbles to the sludge.
- Flotation unit: This is used for bringing the sludge attached with air bubbles to the surface and collecting the thickened sludge.
- Water level adjusting unit: This lowers and raises water level inside the flotation unit in order to adjust the solids concentration of thickened sludge and remove separated liquid (from the solids-liquid separation process) by overflow.

In addition, accessory equipment includes a deaeration tank, foaming agent dosing equipment, high polymer coagulant dosing equipment and air compressor (see **Figure 11-1-20**).

Figure 11-1-20 Flow of Atmospheric Pressure Flotation Thickening System



Sludge that is removed by the sludge feed pump is supplied to the mixing unit. The foaming unit is supplied with air, foaming water and foaming agent for producing micro-bubbles, which are made by the turbine blades inside the unit. In the mixing unit, the sludge is mixed with the air bubbles and high polymer coagulant so that the air bubbles firmly affix to the sludge solids. The sludge with air bubbles is then sent to the flotation unit, where buoyancy causes solids-liquid separation to instantaneously occur. The floating thickened sludge is collector by the sludge collector.

When conducting the inspection and maintenance of this equipment, it is advisable to follow check lists and inspection record sheets, etc. that have been established beforehand for each equipment.

- Routine inspections

  The following items should be recorded in inspection daily logs and operation logs and effort should be made to discover and address failures quickly and ensure efficient operation management.

  A. Current value, abnormal noise and abnormal vibration in each instrument.
  B. Check the lubricant level in the decelerator.
  C. Solids content and feed quantity of supplied sludge
  D. Dosage and remaining quantity of chemicals
  E. Air flow
  F. Foaming water flow
  G. Condition of the separated liquid
  H. Solids content of thickened sludge
- Periodic inspections

  A. Check for stretching of the chain at the flotation unit sludge collecting section. If it is stretched, adjust by means of the chain length adjustment bolt.
  B. In cases where the flotation unit sludge collecting section has wheels, check the running state of the wheels and remove any foreign objects from the shaft, etc.
  C. If clearance between the collecting blade and running rail has become too narrow, adjust by means of the adjusting bolt.
  D. Periodically replace lubricant.
  E. Depending on the attached position of the sludge concentration meter, since air pockets can form and cause error in measured values, the air should be periodically removed. Also, it is

advisable to periodically calibrate the sludge concentration meter based on actual measured values.

(2) Maintenance of anaerobic digestion tank equipment

When sludge is placed in an environment where free oxygen (oxygen in air or water that doesn’t combine with other elements) doesn’t exist, the organic matter in the sludge is decomposed by the activity of various anaerobic microbes, and the sludge is eventually transformed into relatively stable organic matter, inorganic matter and digestion gas.

Microbes concerned with digestion are broadly divided into facultative anaerobic bacteria (acidogens, etc.) and strictly anaerobic bacteria (methanogens).

Organic matter is decomposed via the following two stages by anaerobic bacteria. In the first stage, organic matter in sludge such as carbohydrates, proteins and fats, etc. are broken down into liquid, gas, low-grade fatty acid (organic acid), alcohol, carbon dioxide (carbon gas), hydrogen, ammonia and hydrogen sulfides, etc. This initial stage is referred to as acidic fermentation or acidic decomposition.

In the second stage, the intermediate produced substances from the first stage are broken down into final products such as methane, carbon dioxide, ammonia and hydrogen sulfides, etc. through the action of methanogens). Since this stage takes place in a weak alkaline environment suited to the growth of methanogens, the second stage is referred to as alkaline fermentation, alkaline decomposition or methane fermentation.

The sludge digestion process can either be a single-step approach, in which digestion is completed in a single tank, or a two-step approach, in which two or more serial or duplex tanks.

Single-stage digestion is adopted in cases where the concentration of sludge inserted into the thickening tank is held high by mechanical thickening and as a result the digested and thickened sludge can be dewatered in dewatering equipment without separating liquid from solids in the digestion tank. In single-stage digestion, since only biological reaction is carried out in the sludge digestion tank without conducting solids-liquid separation, there is no separated liquid. Accordingly, as solids-liquid separation only occurs in the dewatering equipment, compared to two-stage digestion where dewatering is carried out after conducting solids-liquid separation in a secondary tank, the overall solids recovery rate is high and the load placed on sewage treatment facilities is reduced. Also, since less sludge can be put into the digestion tank when the concentration of sludge is higher, tank capacity can be reduced and the heating value needed to heat the tank can be saved on.

Two-stage digestion comprises a primary tank for conducting biological reaction and a secondary tank for separating digested sludge from the separated liquid. Heating and stirring are conducted in the primary tank, after which the sludge passes to the secondary tank, where solids-liquid separation is carried out and the sludge concentration level is increased. The number of days required for digestion in the primary tank and the secondary tank differs in the ratio of 1:1 ~ 2:1. When inserting sludge, care should be taken to greatly alter the balance of acidogens and methanogens, and the inserted sludge should be mixed together with the sludge inside the tank in order to accelerate the decomposition. Sludge that has finished the reaction process is transferred to the secondary tank where, after being left for a while, it is separated into digested sludge with relatively high solid content and separated liquid of low SS concentration, and both components are then removed from the tank and sent to the next treatment facilities. However, in recent years, solids-liquid separation is not conducted in the secondary tank and digested sludge is increasingly sent to the dewatering process as it is.

Reasons for the decline in solids-liquid separation inside the secondary tank are, 1) because the inserted sludge has high organic content and the ratio of excess sludge is increasing, the sludge has poor settling characteristics, and 2) because the design number of digestion days cannot be secured, partial gas generation occurs in the secondary tank and impedes the settling characteristics.

Inspections and maintenance of anaerobic digestion tank equipment should be implemented on the following items at appropriate intervals:

- Accumulated sediment, etc.
- Method of grit removal
- Safety management

When the sludge digestion tank is used for many years, sediment and scum accumulate inside the tank, causing the effective capacity and capability to decline. Accordingly, the amount of accumulated sludge should be surveyed and if necessary the tank should be emptied and the sediment and scum removed. At such times, repair work should be conducted on the mixing unit and on cracking inside the tank.

a) Survey of accumulated sediment, etc.

Concerning the interval after which the tank should be emptied so that grit removal and repairs can be carried out, around 10 years is suggested, although this will differ according to the level of incoming sludge, etc. The following simple method can be used to estimate the amount of accumulated sediment and scum.

Concerning accumulated sediment, a weight is attached to a rope with graduations and this is lowered from the sampling hatch on the roof of the sludge digestion tank. The wet depth is measured when the weight reaches the bottom of the tank. Meanwhile, if the depth from the sampling hatch to the tank bottom is measured by means of tank cross section, the depth of sediment can be estimated from the differential between the two measurements.

Concerning scum, if a monitoring window is fitted inside the sludge digestion tank roof, the scum layer can be estimated by observing the water surface. If a stubborn layer of scum has formed on the surface, waves will not occur in that area even if scum stirring is carried out. If waves can be observed over the entire surface, the scum layer is light.

Moreover, reduction in the effective capacity of the sludge digestion tank can be forecast from the properties of the digested sludge. However, because the sludge digestion tank is basically a closed structure and only has a handful of sampling hatches in limited positions, there is a limit to how far direct measurement can be made.

Accordingly, tracer surveying is used to measure the effective capacity of the sludge digestion tank. Capacity can be estimated from the results of survey. In this method, ample lithium chloride is dosed into the tank and mixed with the sludge; after the initial concentration is established, sampling is periodically conducted from the sludge removal pipe, the runoff curve is sought from the concentration of lithium chloride in the sludge, and the dead storage volume and short path volume are adjudicated. Lithium chloride is appropriate as the tracer substance because it doesn’t impede the anaerobic digestion, the analysis method is simple and the background value is sufficiently low.

b) Grit removal method

Removal of grit and scum from the sludge digestion tank should be conducted while considering the execution period and method with a view to minimizing increases in load on treatment facilities. The following methods are used for removal.

(a) First, as much sludge as possible is removed from the tank along the usual removal channel and this is dewatered.

In this case, if the water level falls too much, since there is risk that digestion gas will gush from the sampling hatch, diluting water should be inserted in a quantity slightly higher than the amount of removed sludge. Secondary treated effluent should be used as the diluting water. Doing this serves to reduce temperature inside the sludge digestion tank and dilute the sludge.

(b) After confirming that sludge inside the digestion tank almost totally disappears, the temperature declines and methane gas generation stops, open the gas dome, etc. and conduct ample ventilation of the tank by using a fan. Next insert a sand pump and remove scum together with the diluted sludge in the upper layer. The removed scum is eliminated in the separator, and it is desirable that only the separated liquid is returned to the water treatment facilities.

(c) After draining water away almost to the bottom of the tank, remove accumulated grit, etc. while injecting diluting water. The removed grit, etc. should be separated in the sedimentation tank, etc. and eventually washed and disposed together with the aforementioned scum.

c) Safety management

When conducting grit removal and cleaning inside the sludge digestion tank, it is especially important to carry out thorough safety management such as preventing smoking or use of naked flames inside and outside of the tank in order to prevent gas explosions.

The items required for safety management are generally as follows:

- Since the sludge digestion tank is classed as an oxygen depletion risk area, a work supervisor should be appointed. Moreover, the entrance to the tank should have a sign indicating ‘Oxygen depletion risk area’. When entering a tank, ample ventilation should be conducted and measurements should be made of oxygen, sulfur oxide gas and flammable gas concentrations. It should be confirmed that oxygen concentration is 18% minimum, sulfur oxide gas content is no higher than 10 ppm and flammable gas concentration is less than 5%. While people are inside a tank, the supervisor should be assigned to ensure safety.
- When performing coating work that uses coating materials including organic solvents inside a tank, in order to prevent poisoning by the organic solvent, a work supervisor should be appointed and safety measures such as ventilation should be adopted.
- When restarting use of a sludge digestion tank, sludge should be inserted after first filling the tank with water and replacing the air around the gas dome with inert gas such as nitrogen, etc. If this replacement work is omitted, air will mix with the digestion gas and there will be a risk of explosion, albeit temporary.

(3) Maintenance of sludge dewatering equipment

Sludge substances entering the treatment plant as sewage are removed as sludge in the water treatment facilities and conveyed to the sludge treatment facilities. Except for cases of incineration and effective utilization, sludge dewatering equipment is the final equipment for disposing of sludge outside of the plant.

Sludge dewatering is the process for turning fluid sludge occurring in the water treatment processes into solid sludge (dewatered sludge) for removal from the system. Doing this contributes to higher efficiency in subsequent sludge treatment and disposal processes. Generally speaking, the water content of thickened or digested sludge is somewhere between 94~98%. When sludge in this state is dewatered to a water content of around 75~85%, liquid sludge turns to sludge cake, which has reduced volume and is much easier to handle.

Sludge dewatering has the following roles:

- Volume reduction of sludge through mechanical solids-liquid separation
- Facilitation of sludge incineration and disposal

Sewage treatment is only completed when sewage is treated to a good quality and all generated sludge is treated without delay, and sludge dewatering is a key factor in this. In particular, if there is decline in the capability of dewatering, which is situated before the final treatment or incineration of sludge, because this will hinder the treatment and disposal of sewage and sludge in the whole plant, it is important to conduct the appropriate maintenance of dewatering equipment.

Sludge dewatering can target either raw sludge or digested sludge. In either case, because the sludge contains a lot of organic matter with high affinity for water and it comprises particles of various shapes and sizes with high potential for compaction, it is difficult to conduct dewatering in that state. Accordingly, it is necessary to conduct sludge adjustment as preliminary treatment in order to improve the dewatering characteristics of the sludge.

a) Types of dewatering system

Sludge dewatering systems mainly adopt mechanical methods. Sludge that has been improved in adjusting equipment is mechanically dewatered in a dewatering machine and turned into solid dewatered sludge with low water content. Sludge dewatering methods include the following:

- Vacuum filter (utilization of vacuum)
- Pressurized filter (utilizing compaction force)
- Belt press filter (utilizing compaction force and shearing force)
- Centrifugal dewatering machine (utilizing centrifugal force)
- Multiple plate screw pressure dewatering machine (utilizing compression force)
- Multiple disc dewatering machine (utilizing compaction force)

Of these systems, the vacuum filter, pressurized filter and belt press filter are filtration and dewatering methods that use perforated filter cloth.

b) Inspection and maintenance of chemical dosing equipment

Sludge is mainly composed of colloid particles and, because the surface of sludge particles is negatively charged making the particles repel each other, it is difficult to mechanically dewater the sludge as it is. Accordingly, chemicals are added to the sludge in order to reduce resilience between particles, increase coagulation, form larger particles (floc generation) and improve the sludge solids-liquid separation and dewatering properties. This is referred to as sludge adjustment and aims to physically and chemically improve the nature of sludge and facilitate the coagulation of particles.

Sludge adjustment is carried out using high polymer coagulant (polymer) or inorganic coagulant (iron chloride, etc.) depending on the type of dewatering machine. Compared to inorganic coagulant, since high polymer coagulant requires a far lower dosing rate, the quantity of dewatered sludge doesn’t increase and this is convenient for incineration and landfilling. There are more and more dewatering methods that utilize high polymer coagulants in recent years.

Sludge adjustment equipment includes sludge washing tanks, chemical dosing equipment and granulation equipment, etc. The method for adjusting sludge quality differs according to the properties of sludge and methods of sludge treatment and disposal in the subsequent stage, however, generally the following kinds of combinations are adopted to conduct adjustment and dewatering:

- Thickening – Chemical dosing – Dewatering (belt press or centrifuge, etc.)
- Thickening – Anaerobic digestion – Washing – Chemical dosing – Dewatering (vacuum or pressurized filter)
- Thickening – Anaerobic digestion – Chemical dosing – Dewatering (belt press or centrifuge, etc.)
- Thickening – Granulation – Dewatering (belt press)

The following sections describe inspections and maintenance for the chemical dosing equipment.

When conducting the inspection and maintenance of this equipment, it is advisable to conduct inspections according to check lists and inspection record sheets, etc. that have been established beforehand for each equipment.

- Routine inspections
  Routine inspections should be implemented based on visual inspection.
  A. Check for any abnormal noise, abnormal vibration and heating during operation.
  B. Check the current value.
  C. Check the operating conditions.
  D. Check the lubricant level and for any oil leaks or dirt in the pumps and decelerator.
  E. Check the conditions of mixing inside the water tanks.

- Periodic inspections
  A. Tighten loose nuts and bolts.
  B. Inspect inside tanks.
  C. Confirm the state of pump and mechanical seals.
  D. Confirm abrasion in pump joints and stators.
  E. Replace worn or damaged parts (bearings, scrapers, etc.)

c) Inspection and maintenance of centrifugal dewatering equipment

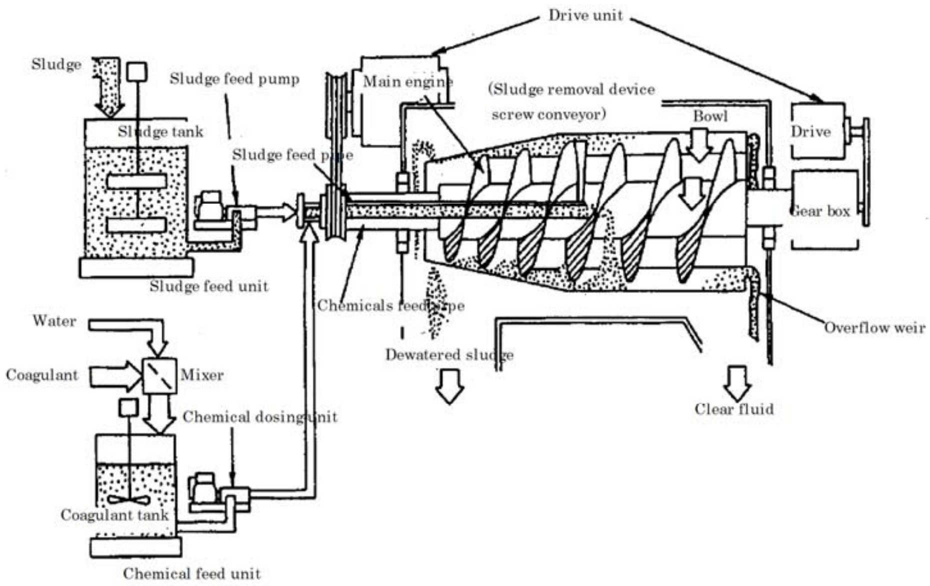
The centrifugal dewatering machine utilizes centrifugal force to dewater and separate sludge, and the horizontal type machine is frequently used. Centrifugal dewatering entails imparting centrifugal force 1,500~3,000 times greater than gravitational acceleration to chemically dosed and adjusted sludge, and thereby separating in a short time the kinds of micro particles that cannot be separated in gravity separation processes. **Figure 11-1-21** shows an example of the horizontal continuous centrifugal dewatering machine.

The supplied sludge is mixed with chemicals to form sludge floc, and this is subjected to centrifugal force in a spinning drum that leads to solids-liquid separation.

The separated solids are discharged as dewatered sludge while being compacted along a screw conveyor, which is driven by a speed differentiating unit at a slower rate than the drum revolution speed. An overflow dam is often used for removing the separated liquid.

Since sand and foreign materials in the sludge can lead to abrasion and blockage of the dewatering machine, it is necessary to remove and destroy such objects in advance. Chemicals can be dosed by mixing with sludge outside of the machine or by mixing inside the machine upon supplying through a separate pipe from the sludge. When dosing chemicals outside of the machine, since floc that is initially formed is crushed inside the machine, a lot of product must be supplied in advance. In cases where dosing is implemented inside the machine, the dual pipe approach is usually adopted because it enables better sludge separation and less quantity of chemicals.

Figure 11-1-21 Example of a horizontal centrifugal dewatering machine



When conducting the inspection and maintenance of this equipment, it is advisable to conduct inspections according to check lists and inspection record sheets, etc. that have been established beforehand for each equipment. Inspections and maintenance should be conducted while paying attention to the following points.

- Routine inspections

A. Autonomous inspection should be conducted once per year.

B. Make sure that lubricant level is appropriate in the main bearings and decelerator and that internal bearing are sufficiently greased.

C. Inspect temperature of the main bearings.

D. Pay attention to the current value during stable operation and voltage drop during startup.

E. Inspect vibration in the dewatering machine and motor.

F. Inspect the extent of looseness and damage in the V-belt around once per month or every 2 months.

G. Clean the insides of the dewatering machine at appropriate intervals.

H. Record the following items in the inspection daily log and operation daily log and strive to conduct efficient operation management through discovering and treating breakdowns at an early stage.

Mechanical items: current value, bearings temperature and abnormal noise.
Performance items: amount of supplied sludge, chemical dosing quantity, solids concentration of supplied sludge, SS of filtrate, water content of dewatered sludge

d) Inspection and maintenance of pressurized dewatering equipment

As is shown in **Figure 11-1-22**, the pressurized filter dewatering machine comprises filtration chambers made by combining 2 filter plates with filter cloth, and the necessary numbers of chambers are installed in a line according to the necessary capacity. Filter cloth comprises either separate pieces for each chamber or an endless roll running between all the chambers. Pressurized filters comprise either single type filters or multiple type filters, while the filter cloth tightening method can either be manual, hydraulic or motor-driven. Moreover, in order to reduce the water content of dewatered sludge, some filter machines are equipped with a compressing mechanism that squeezes the sludge at high pressure, while others adopt a running system for the filter cloth geared to shortening the various time spent on non-filtering operations. The pressurized filter can produce dewatered sludge with lower water content than that obtained from the vacuum filter.

In the filtration and dewatering processes, sludge is fed to the filtration chambers by sludge pressure insertion pump. Moreover, in filters that have a compressing mechanism, compression is implemented through supplying high pressure water or oil, etc. to a diaphragm (having a film that changes shape under air or water pressure) attached to the filter plates, and the compressed air is used to remove water content inside the filtration chambers and filtrate pipes, etc. After that, the filter plates are opened and the dewatered sludge is removed (see **Figure 11-1-23**).

Figure 11-1-22 Example of a Pressurized Filter

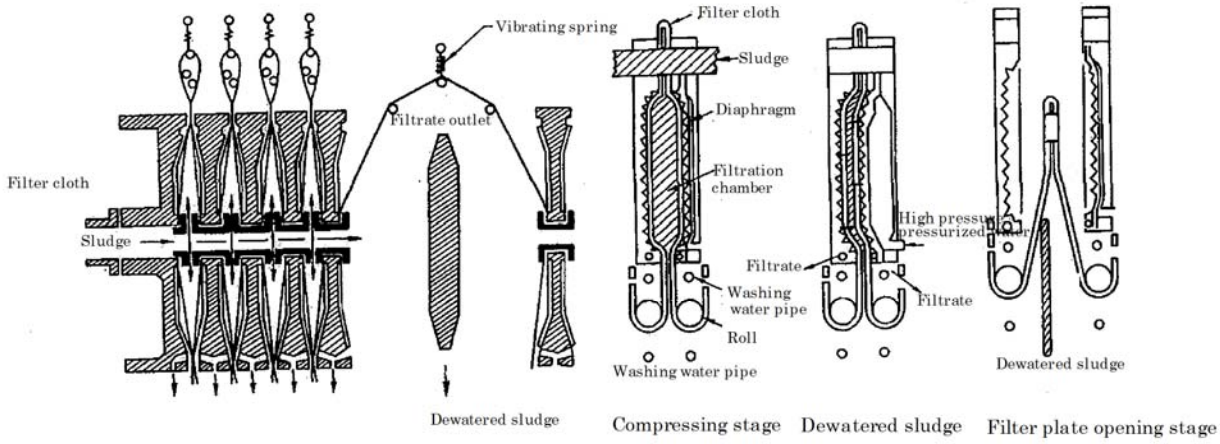
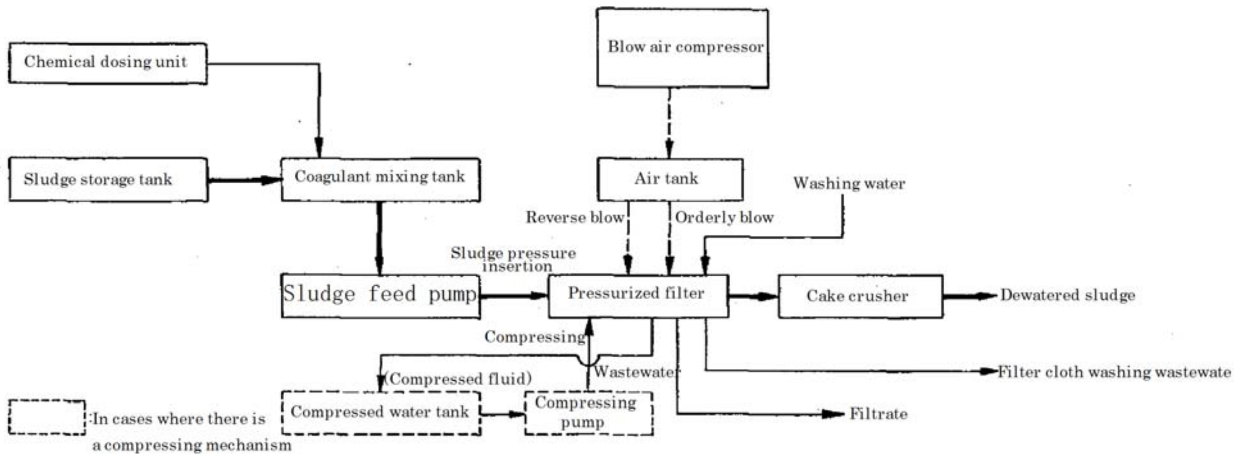


Figure 11-1-23 Example Flow Sheet of the Pressurized Filter



When conducting the inspection and maintenance of this equipment, it is advisable to conduct inspections according to check lists and inspection record sheets, etc. that have been established beforehand for each equipment. Inspections and maintenance should be conducted periodically while referring to user manuals and paying attention to the following points.

- Inspect the condition of lubrication to each main part.
- Inspect and clean the hydraulic unit strainer and check the oil surface.
- Periodically drain the air tank.
- Inspect the instrumentation such as pressure gauges, etc. to make sure they are operating normally.
- Since filter cloth is prone to clogging and tearing, spare filter cloth should be kept on hand at all times. When the filter cloth becomes clogged, this causes the filtration speed to drop and chemical dosing rate to increase. Since clogging of cloth differs according to the properties of

supplied sludge and type of cloth, the cloth replacement date should be recorded and the optimum replacement interval prescribed based on past experience. Filter cloth that is used for around 6 hours a day is said to become clogged after around 300~500 hours of operation. When washing (regenerating) filter cloth, it is desirable to remove and wash with acid. After acid washing, the cloth is neutralized and washed with water, etc. Hydrochloric acid should always be maintained at the designated concentration. The acid washing time varies according to the extent of sludge clogging, however, it usually entails between 30~60 minutes of steeping.

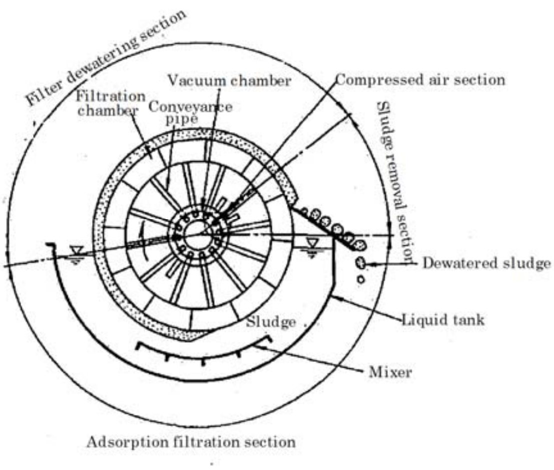
- Scale should be periodically cleaned away from filtrate channels on the filter plates.
- Since the filter plates are closed with a large force, check for cracking or damage in the plats and make sure that packing around the sludge supply inlet and filtrate outlet is not damaged.
- Record items in the inspection daily log and operation daily log and strive to conduct efficient operation management through discovering and treating breakdowns at an early stage.

e) Inspection and maintenance of vacuum dewatering equipment

The drum type vacuum filter comprises a drum wrapped with synthetic fiber filter cloth. After sludge is steeped in the liquid tank that covers around 1/4 of the drum area, the drum is rotated at a speed of roughly 1/3～1/8min^{-1}, while the drum is depressurized in the adsorption, filtration and dewatering sections and pressurized air is blasted from the rear in the peeling section, so that the dewatered sludge can be easily peeled off (see **Figure 11-1-24**).

The nominal treatment capacity of the vacuum filter is expressed as the product of the filtration area and filtration speed. In terms of maintenance, it is desirable to secure the filtration speed that was prescribed at the time of design.

Figure 11-1-24 Example of a Drum Type Vacuum Filter

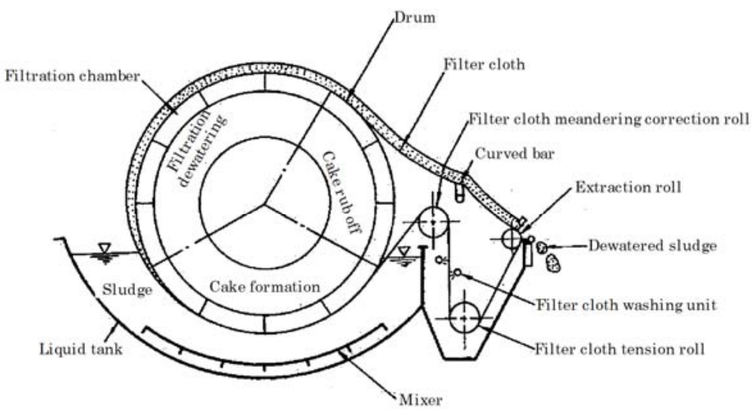


As is shown in **Figure 11-1-25**, in the belt type vacuum filter, filter cloth is hung between 3 or 4 rollers and stretched over the drum. The major differences with the drum type vacuum filter can be summarized into the following points:

- Since the filter cloth is washed in the washing unit while the drum is still rotating, it takes longer to reach the stage of acid washing to remove clogging.
- There is no need to conduct pressurization in order to remove the dewatered sludge.
- Water is needed to wash the filter cloth.
- When peeling of the dewatered sludge is poor, sludge runs out together with the filter cloth washing wastewater.

- The filter cloth sometimes meanders.

Figure 11-1-25 Example of a Belt Vacuum Filter



When conducting the inspection and maintenance of this equipment, it is advisable to conduct inspections according to check lists and inspection record sheets, etc. that have been established beforehand for each equipment.

- Drum vacuum filter

  Inspections and maintenance should be conducted as follows.

  A. Inspect the condition of lubrication to each main part.

  B. Check for any abnormal noise in the drum, sludge mixer and other drive parts.

  C. Check for any clogging or tearing of the filter cloth.

  D. Check for any sludge attachment or clogging of plates and clogging of conveyance pipes, etc.

  E. Make sure that no sludge pieces are attached to the pole bolt for liquid surface control.

  F. Check for attachment of and clogging by scale mixed with calcium carbonate, calcium sulphate and sludge in the liquid tank sludge discharge pipe, overflow pipe and sludge feed pipe, etc. Moreover, although not as serious as in the above pipes, since scale also attaches to filtrate pipes, similar inspections are required. Depending on the inspected conditions, it is sometimes desirable to remove scale with a special high pressure water washing unit, etc.

  G. Filter cloth that has good mechanical strength, good resilience, small water absorption, and excellent corrosion resistance and abrasion resistance should be used. Generally, filter cloth made from synthetic textile such as nylon, tetron, vinylon, polypropylene and saran, etc. is used. Moreover, the hardened gum packing, etc. is used for fixing the filter cloth to the drum, while stainless steel wire is used as fixing wire.

  H. Since filter cloth gradually becomes clogged and filtration speed drops when it is used for a long time, spare filter cloth should always be kept on hand.

  I. The total operating time the filter cloth can be used before it needs acid washing clogging of cloth differs according to the properties of supplied sludge, the quantity of dosed calcium hydroxide (slaked lime), type of cloth, the past frequency of washing and the daily operating time, however, it is somewhere between 200~500 hours. The total time before replacement is around 1,000~1,300 hours. Total operating times up to washing and replacement should be recorded and referred to.

  J. When washing (regenerating) clogged filter cloth, the drum should be rotated in a tank filled with dilute hydrochloric acid. If the filter cloth can be detached and re-attached easily, it is desirable to remove and conduct acid washing. When conducting acid washing inside a liquid tank, since the interior of the filter is prone to corrosion, it is necessary to thoroughly understand the filter materials, etc. After acid washing, the cloth is neutralized and washed with water, etc. If conducting acid washing of nylon filter cloth in the attached state, hydrochloric acid should be maintained at 2~3% concentration in consideration of the acid resistance of the filter cloth. The acid washing time varies according to the extent of sludge clogging, however, it usually entails between 30~60 minutes of steeping. If conducting acid washing without removing filter cloth from the drum, the washing should be continued for 3~4 hours while slowly rotating the drum and adjusting the concentration of hydrochloric acid.

K. Concerning recording in inspection daily logs and operation daily logs, see the section on the centrifugal dewatering equipment.

- Belt vacuum filter

Inspections and maintenance should be conducted as follows.

A. Check for any abnormal noise in the drum, sludge mixer, rolls and other drive parts.

B. Make sure that the meandering correcting unit is operating normally.

C. Check for any clogging of the filter cloth washing water spray nozzle, and make sure that the discharge pressure is appropriate.

D. Inspect and clean the filter cloth washing strainer.

E. Check for attachment of and clogging by scale mixed with calcium carbonate, calcium sulphate and sludge in the filter cloth washing drainage pipe and gulley. Also check for and clean blocked pipes and overflowing gulleys. It is desirable to remove scale with a special high pressure water washing unit, etc. around once every two years.

F. When replacing the filter cloth, fix one end of the cloth to the drum, rotate the drum once and affix the other end by fastener. Alternatively, the two ends of the filter cloth can be sewn together using thread of the same material.

G. Concerning other items, refer to the section on the drum vacuum filter.

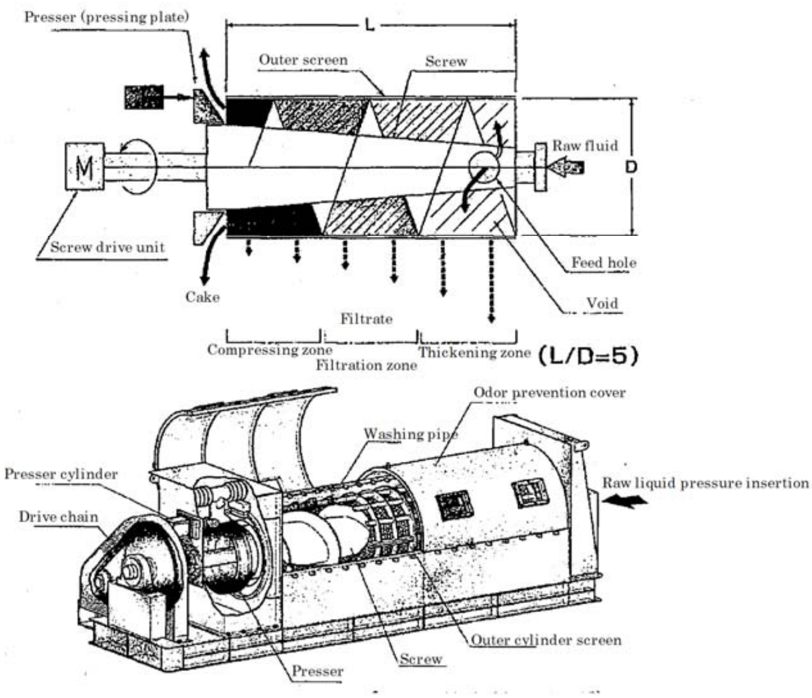
f) Inspection and maintenance of screw press dewatering equipment

As is shown in **Figure 11-1-26**, the screw press dewatering machine is composed of a cylindrical screen and conical screw blades, and the gap between these two parts decreases moving towards the dewatered sludge outlet. Sludge that has been adjusted with high polymer coagulant is fed between the screw and screen and dewatered continuously through rotating the screw. Gravity filtration is conducted in the first part of the dewatering machine while dewatering is performed from the middle stage by means of pressure applied by action of the screw blades and shearing force from rotation. The separated filtrate passes through the cylindrical screen and is discharged from the machine.

The screw rotates slowly at no more than $2min^{-1}$. There is no need to wash the screen during dewatering, but this can be performed following the completion of dewatering.

Since the screw press dewatering machine depends on the compression and shearing force of the screw blades, the treatment capacity is greatly impacted by keeping sludge adequately filled between the screw blades. The nominal treatment capacity of the screw press dewatering machine is expressed in terms of the DS treatment flow. In order to ensure operation at a DS treatment flow close to the nominal treatment capacity, it is desirable to keep the solids concentration of sludge close to the design value.

Figure 11-1-26 Example of the Screw Press Dewatering Machine



When conducting the inspection and maintenance of the screw press dewatering equipment, it is advisable to conduct inspections according to check lists and inspection record sheets, etc. that have been established beforehand for each equipment. Inspections and maintenance should be conducted on the following items.

- Routine inspections
  A. Check for any abnormal noise or vibration in the screw driver section.
  B. Check for any damage or clogging in the screen.
  C. Check for any clogging of the washing water spray nozzle.
  D. Check the operating state with the presser air pressure set to minimum operating pressure of 0.1 MPa.
  E. Check for any abnormal noise and vibration in the coagulation mixer.
  F. Check lubricant levels and for any oil leaks.
  G. Check ammeter readings and display lamps, etc. on local panels, etc.
  H. Check the operating state of instrumentation.
- Periodic inspections
  It is desirable to implement periodic inspections once per year in order to sustain the performance levels of equipment.
  A. Tighten nuts and bolts to ensure there is no looseness.
  B. Check for any damage or degradation in packing and O-rings.
  C. Check for any abnormal noise in bearings.
  D. Replacement lubricant.
  E. Check for any abnormality in the detecting parts of instrumentation.
  F. Implement correction of values indicated by instrumentation equipment.
  G. Measure insulation resistance of main circuits and control circuits inside the control panel.
- Overhauls
  Overhauls should be implemented in order to sustain functions over the long term. Implementation intervals vary according to the operating conditions, however, it is desirable to implement once every few years.
  A. Conduct disassembly inspection.
  B. Replace expendable parts.

C. Replace lubricant.
D. Conducting recoating.

6) Work subcontracting

When subcontracting maintenance work, it is necessary to adopt a setup whereby work can be implemented efficiently and smoothly upon complying with legislation related to dispatch of workers and clarifying the scope and division of responsibility of maintenance work.

When treatment starts in sewage facilities, this must be continued 24 hours a day and personnel must be assigned to each post to ensure this. However, since it is difficult o secure personnel and maintenance work is largely made up of formulaic work, simple work and on-site work, some or a lot of the work is sometimes contracted to private sector operators.

(1) Scope of work subcontracting

Since sewage systems, having the objectives of preventing flooding, improving the living environment and enhancing water quality in the public water body, are important facilities for ensuring public lifestyles and social activities, their maintenance entails a high level of administrative responsibility.

Accordingly, concerning the following basic maintenance work and activities that concern the exercise of public authority, it is natural that the MWSS (MWSI/MWCI) assume primary responsibility:

- Implementation of on-site inspections concerning water quality regulations in factories, etc.
- Authorization of inflows from outside of treatment districts, approval of works, etc.
- Administrative dispositions such as improvement orders and supervised disposal, etc.
- Review concerning notifications for installation of specific facilities
- Imposition of sewage charges, etc.
-

However, other maintenance activities such as survey and cleaning of conduits, operation of treatment facilities, treatment and disposal of sludge, water quality test and analysis work, etc. can be consigned to the private sector.

For example, water quality testing and analysis should be implemented under the responsibility of sewage system managers, however, it is sometimes outsources in cases where such work requires purchase of expensive instruments and cases where it is difficult o find human resources to look after sophisticated instruments.

(2) Selection of subcontractors

Since the sewage system plays an important role in preserving water quality in the public water body, it is especially important to conduct maintenance appropriately and economically. Accordingly, when conducting maintenance of pumping and treatment facilities, system managers must consign work to people who possess the legally required qualifications. Moreover, when consigning water quality testing and analysis work, this must be conducted by an officially recognized agency.

Accordingly, when consigning maintenance of pumping and treatment facilities to the private sector, it is necessary to assign a full-time engineer who possesses a certain degree of qualifications according to the consigned contents. Similarly, it is desirable to deploy a suitably qualified engineer when consigning maintenance of conduit facilities to the private sector.

7) Training

Since the maintenance of sewage system facilities requires a wide range of expert knowledge and technology, it is necessary to conduct planned and efficient training geared to building the capacity of maintenance personnel.

Workshops and training tour including oversea training plan will be recommended.

8) Disaster countermeasures

Disasters surrounding sewage system facilities include flooding of suburban land caused by typhoons and abnormal rainfall, earthquakes, breaching of embankments and inundation caused by high tides, explosions caused by the large-scale inflow of volatile oils, chlorine leaks inside treatment plants, gas explosions and fires, etc.

In order to respond to such situations, it is necessary to establish the operation and activities of disaster prevention organizations, arrange emergency assignments, compile staff mobilization plans and install a crisis management setup for responding to situations. It is also important to appropriately inform and provide information to residents.

11.1.2 Institutional Study of MWSS and MWSI/MWCI

1) Institutional Study for MWSS

(1) Current Roles and Issues of MWSS

The followings shows the current roles and issues or concerns of MWSS

a) Background

Republic Act 6234 which was promulgated in 1971, established the MWSS Charter and, along with it, the basic and broad policies and goals of the MWSS System. The main function of the MWSS under the Charter is to provide clean potable water; contribute to public health and safety through the maintenance and improvement of the urban environment and securing of a sanitary environment; and secure environmental conservation to preserve the quality of human life and ecological systems and prevent ecological deterioration and pollution. It was mandated, among other things, to construct, maintain, and operate dams, reservoirs, conduits, aqueducts, tunnels, treatment plants, water mains, pipes, fire hydrants, pumping stations, machineries and other water works all aimed at ensuring that it is able to accomplish its main functions under its Charter.

In 1995, the Philippine Congress passed RA 8041 or the 1995 Water Crisis Act, which is an "*Act to Address the National Water Crises and for Other Purposes.*" This act declared the policy of the State to adopt urgent and effective measures to address the nationwide water crisis which adversely allocate the health and well-being of the population, food production and industrialization process.

Pursuant thereto the government shall address the issues relevant to the water crisis including, but not limited to, supply, distribution, finance, privatization of state-run water facilities, the protection and conservation of watersheds and the waste and pilferage of water, including the serious matter of graft and corruption in all the water agencies.

In August, 1997, the operation, maintenance and expansion of the MWSS service area was transferred to the two concessionaires under the Concession Agreement (CA) thru International Competitive Bidding; Manila Water Company, Inc. (MWCI) for the East Zone and Maynilad Water Services, Inc. (MWSI) for the West Zone. The CA embodies the responsibilities of MWSS and its Concessionaires in the latter's exercise of certain rights and powers for a period of 25 years.

The Regulatory Office of MWSS was established under the provisions of the concession agreements as the representative of the customers. It is responsible for monitoring the concession agreements generally and monitoring specifically the performance of the concessionaires including sponsoring technical and financial audits. It also has the core role of facilitating and implementing changes to rates and charges.

The MWSS Corporate Office is established implicitly by MWSS's responsibility for the "retained functions". These are specified in the concession agreements to include facilitating (as opposed to regulating) the performance by the concessionaires of their obligations, managing the loans, which are in the name of MWSS but are serviced under the agreements by the concessionaires and managing and where appropriate disposing of the "retained assets" i.e. those assets not conceded for the duration of the agreement. The Corporate Office also takes the lead in the development of long term development of water sources.

The Concession Agreement was extended to additional 15 years or up to 2037 in view of the December 2008 Supreme Court decision on the cleanup of Manila Bay, compliance to Clean Water Act of 2004 and the Millennium Development Goals for sustainable sanitation. The extension was premised on the condition that concessionaires will double its investment for water, sewerage and sanitation and to mitigate the tariff impact by spreading its recovery period of the investment up to 2037. This will result to accelerating the provision of wastewater services in Metro Manila and the development of the long term water sources for water supply safety and reliability.

b) MWSS Paradigm Shift

A sustainable water supply is a cornerstone of self-sustaining communities. In Metro Manila, the provision of water to millions of people in the last 10 years has contributed to improved conditions of many people.

Nonetheless, many people still lack access to water and sanitation as MWSS fulfills many competing functions: protecting public health; meeting industrial, commercial and residential demands; while maintaining environmental quality. Also, the growing population of Metro Manila directly impinge on its dwindling water supply.

Thus, for the past years 13 years, the MWSS, in a privatized set-up, continued to focus on good governance in the context of restructuring its organization in a serious gesture to lay the ground work for a more secure water future and clean environment.

Essential paradigm shifts which will translate MWSS' expressed commitments to its goals, vision, mission and strategic directions and contribute to the development of MWSS into a high performing organization are identified, as follows:

(a) Role

- Lead the water agencies in formulating policies, reviewing operations, identifying gaps in attaining our commitment to the Medium-Term Philippine Development Plan by assuming a more pro-active and direct role as a major planning agency on water and sewerage.
- Direct the efficient and effective allocation of resources to promote water and sewerage projects.
- Strengthen its coordination and network with other development agencies, local governments units, non-government and private organizations, as well as its outreach to the general public to promote water and sewerage development.

(b) Functions

- Initiate review of the Concession Agreement to include special provisions for the creation of a Water Development Fund (or such other appropriate term) and raw water charges and formulation of needed policies to clarify some ambiguous provisions of the CA.
- Put in place the mechanisms to implement its long term projects in developing new water sources like the much-delayed Laiban Dam Project.
- Assume a more active role in coordinating inter-agency efforts to promote water and sewerage development concerns particularly with National Economic Development Authority (NEDA), Department of Finance (DOF) and other anti-poverty agencies.
- Establish a more defined presence in watershed and other protected areas that were placed under the co-administration with the MWSS and explore the possibility of placing these under MWSS sole control and supervision.
- Identify public and private lands which may be used for water and sewerage development projects.
- Implement Presidential Decree 1345 for MWSS and/or its agent to take-over the water supply system of housing subdivision projects.
- Review water and sewerage policies and water sector performance appraisal system along with the development of Management Information System (MIS) to guide policy planning and performance monitoring.

(c) Competencies

- Establish an internal capability build up through purposive career development program that will upgrade existing competencies and engage/hire competent staff.
- Institutionalize planning system to become more of a "knowledge manager" than a project implementer.
- Effect an attitudinal change among its personnel from being bureaucratic to an innovative change-minded and from being plain analytical to cognitive/problem solving.

c) Project Management Committee:

The MWSS Board of Trustees approved the second rate rebasing of the concession agreement (2008 for Manila Water and 2009 for Maynilad Water Services) with the creation and establishment of a Project Management Committee. The Committee are composed of members from the MWSS-Corporate Office, MWSS-Regulatory Office, representatives from MWCI and MWSI. The Committee is created to ensure that the assets at the end of the concession period will be consistent with the provisions of Article 6.5.2 (Asset Condition Report) of the concession agreement. It will likewise review/update the technical standards and specifications of materials, equipment and the like being used by the two concessionaires.

The Project Management Committee shall also review and evaluate projects to be consistent with the CAPEX projects and the overall strategic direction of the submitted Business Plan of the two concessionaires.

(2) Institutional Study

There is an emerging need for MWSS to play a more active role as the lead agency for Metro Manila in water, sewerage and sanitation management by guiding its concessionaires to achieve the higher goal of the sector. This can be achieved by strengthening the capabilities of MWSSS staff through trainings, workshops, exposure/immersion to the latest trends in technology as well as on the job trainings. MWSS is always looked up as model in other parts of the country as well as in within the region in terms of public-private partnership.

a) Empowerment of MWSS Roles

(a) Technical Competencies of MWSS

The MWSS needs to retain within the organization a strong competence level based on a small core of professionals in the fields of water resources planning, sewerage/sanitation planning, engineering and project management to determine and evaluate the need for and oversee the conduct of outsourced services for major water source development and address the many strategic cross concession issues in regard to sewerage and sanitation.

With the thrust to speed up sewer coverage, new strategies were approved by MWSS for implementation one of which is the adoption of a decentralized system using the river basin approach and the use of combined sewer-drainage system. It is necessary for MWSS to reevaluate the comprehensiveness of the present sewerage and sanitation management concept adopted by the two concessionaires.

It is imperative for MWSS technical personnel to enhance their capabilities and knowledge on the different treatment process and best practices/models on the use of combined sewer-drainage system, considering that this is the first time that MWSS will implement such scheme. The challenge includes the sourcing of new technologies which will use minimum footprints as identification and acquisition of site for treatment plants in Metro Manila is very difficult and expensive.

(b) Asset Management

There is a need to provide more detailed asset condition data to the Corporate Office and for the Office to be strengthened to manage and use data in decision making.

Decisions on repair or replacement of assets in the water and sewerage sector are a major component of asset management. Failure of assets will generally have a strong impact on customers and the environment. At the current time, decision making is the sole right and responsibility of the concessionaires, with the Regulatory Office taking a role through the review process associated with the Rate Rebasing. This results in the decisions being generally taken in consideration of the business considerations of the concessionaires. There is no direct input on behalf of the long term asset owner, which is the MWSS.

It is recommended that MWSS being the asset owner should participate in any decision making, which involves assets where lives will directly extend beyond the concession period. The Asset Management Group should be strengthened to undertake the active role.

(c) Capacity Building on Water Rate Restructuring

The Concessionaires were granted an extension of 15 years in their respective concession period or up to 2037. With the said extension of service, the concessionaires are committed to intensify expansion of their services (i.e. water, sewerage and sanitation) in their respective franchise areas under their term expansion plans and programs. Further, the concessionaires are committed to mitigate tariff impact of their respective programs given a longer period to recover their investments.

While the concessionaires are undergoing changes in their environment, it is also appropriate that the Regulatory Office should find ways to adapt to said changes by adjusting its capacity to meet the changing utility regulatory environments. Trainings and workshop are needed to enhance the skills in calculating rates and analyzing financial information; gain knowledge on advance techniques in cost service, determination of Appropriate Discount Rate (ADR) asset usefulness and demand profiling; understand the key principles in rate design, including subsidy design methods to reduce the financial burden of implementing subsidies; and develop an action plan for the tariff restructuring and subsidy design.

(d) Capacity Building to Regulate the Core Business of the Concessionaires

The Concessionaires, by nature of their utility undertakings, has the capability to diversify and/or expand their regulated business in local and foreign markets.

The Regulatory Office needs to enhance its technical and financial capability in terms of adherence to sound economic, financial and customer considerations relative to the expenditures prudently and efficiently incurred in the attainment of the concessionaires' service obligation targets. The Regulatory Office should formulate a working guidelines and/or policies relative to transfer pricing mechanism.

b) Institutional Study

The items mentioned above to enhance MWSS functions and roles should be assisted both by staff training and institutional enhancement. The enhancing institutions of MWSS should stress on asset management and overall business plan management, in order to monitor on and join in implementation of sewerage and sanitation study and planning. Asset management is also essential function of MWSS. For the purposes, Asset management office and Planning and Overall Managing Office should better be established in their organizations.

Figure 11-1-27 shows Present Organization Chart of the MWSS, and **Figure 11-1-28** shows the New Organization proposed. Sections shown in red figures mean additional sections.

Figure 11-1-27 Present Organization Chart of the MWSS

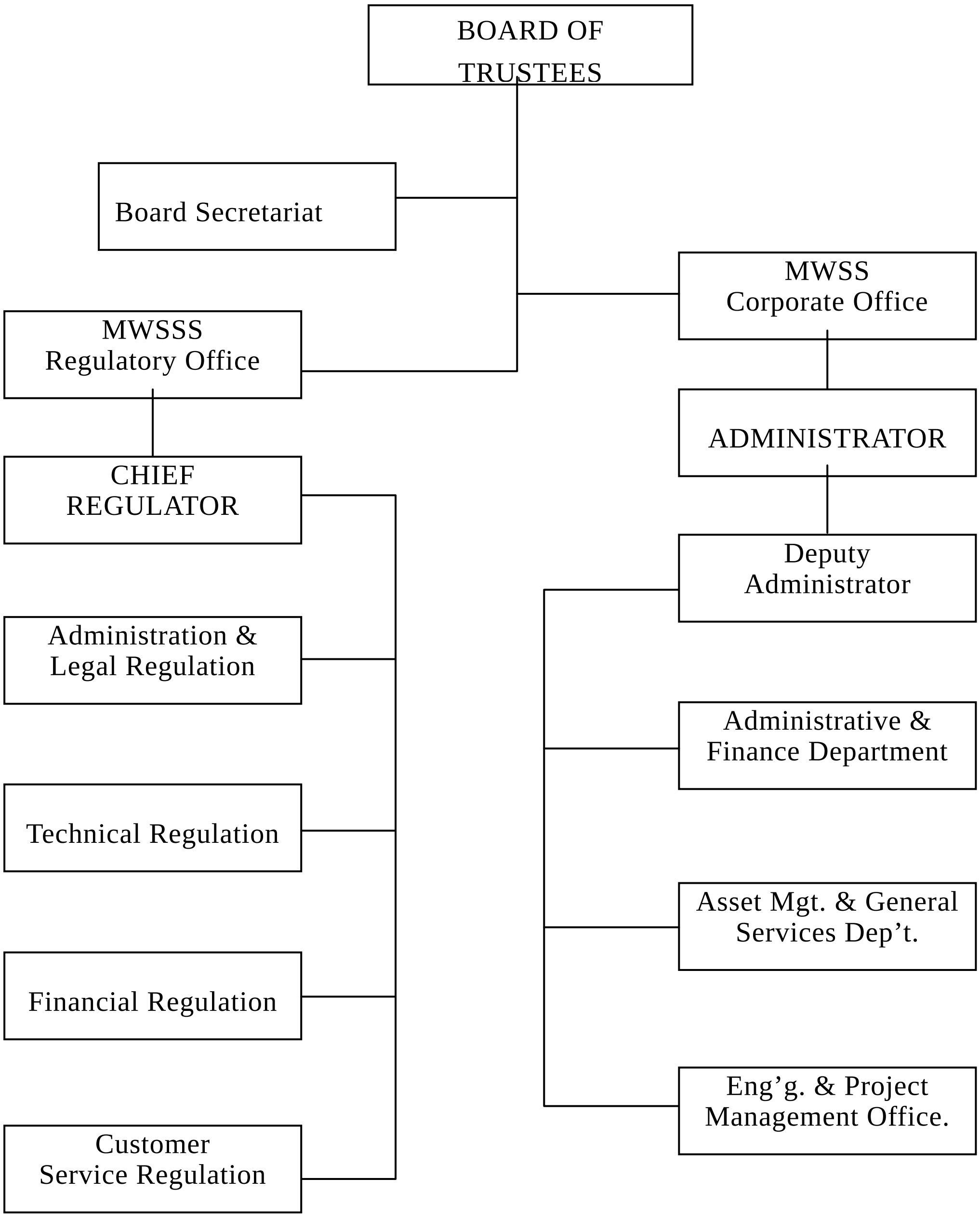
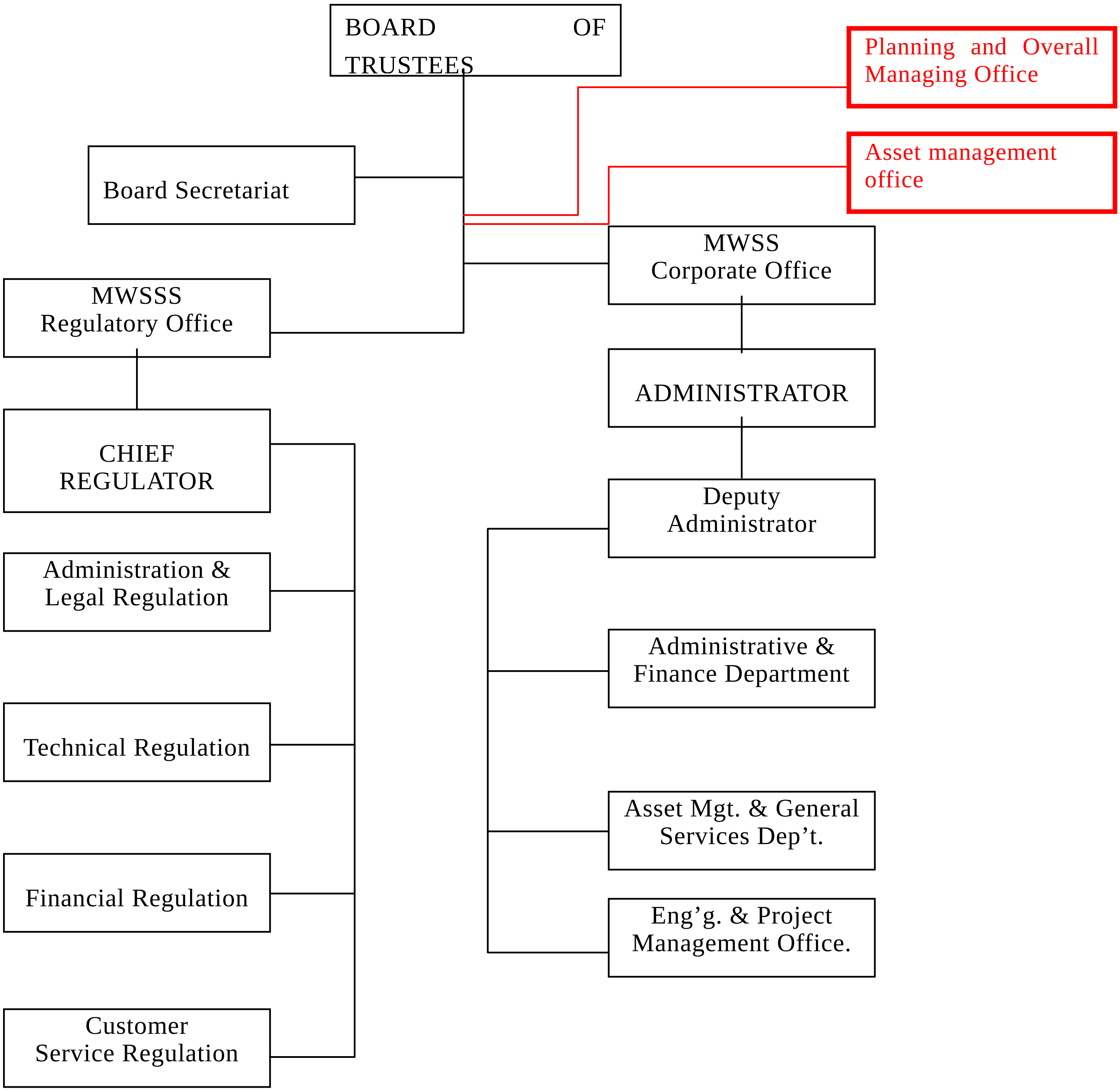


Figure 11-1-28 Proposed Organization Chart of MWSS



Note: Thick lines show additional functions proposed

2) Institutional Study for MWSI

(1) Current roles and problems

The current field facilities and procurement plan shall be studied together with field activities, effectiveness, and contribution to the infrastructures.

a) Equipment currently operating, under construction or scheduled for construction

(a) Sewerage and Sanitation Facilities

Dagat-Dagatan Sewage Treatment Plant (26,000 CMD)

- Oxidation Ditch Process
- Comprises of two sets of parallel lagoons mainly Aerated, Facultative, and Polishing Lagoons

Dagat-Dagatan Septage Treatment Plant (450 CMD)
- Chemical Precipitation Process with Dewatering
- Utilizes Screw Type Press to achieve optimum moisture content for dewatered treated septage

Tondo Sewage Pumping Plant (43,0000 CMD)
- Primary treatment with Aerated Grit Chamber

Alabang Treatment Plant (10,000 CMD)
- Activated Sludge Process
- With Drying Bed and Press for Waste Sludge Dewatering

(b) On-going Sewerage and Sanitation Plant Construction
Upgrading of Communal Treatment Plants
(b)-1 Congressional (ECOSYSTEM as Contractor)
- capacity of 567 CMD
- will utilize SBR Treatment Process with Aerobic Sludge Digester
- target completion will be on November 2010

(b)-2 Grant (DMCI as Contactor and Bauer as Technology provider)
- on-going process design

(b)-3 Legal (DMCI as Contractor and Bauer as Technology provider)
- on-going process design

c) Future plans
Table 11-1-40 shows the future plans of MWSI.

Table 11-1-40 Future plans（MWSI）

PRO JECT	Target Population
San Juan River Basin Project (Target Completion 2012)	550,000
South Septage Treatment Plant (Target Completion 2011)	900,000
Central Manila Sewerage System (Target Completion 2011)	1,003,000
Maricaban Retarding Pond (Target Completion 2013)	300,000
Valenzuela Sewerage (Target Completion 2014)	462,000
Imus-Cavite River Basin (Target Completion 2015-2016)	438,000
Muntinlupa Sewerage (Target Completion 2016)	323,000

d) Problems in the current setup

As described above, MWSS is developing their sewerage and sanitation systems urgently to cater for Clean Act 2004. Effective operation and maintenance system for the facilities shall be required, and enforced to cater for the huge capacities and numbers of sewerage system facilities in future. T**able 11-1-41** shows necessary functions and departments or sections to address the said concerns. At this stage enforcing the construction department would be necessary to keep quality of the facilities and monitor the construction cost to prevent the improper cost rise. And also training and education programs for the staff empowering would be required.

Table 11-1-41 Examination of the Organization required for Maintenance of Sewerage Facilities(1/2)

Organizational setup				Work contents
MWSI/MWCI	Accounting	General Affairs		Accounting and personnel management and other general affairs (including public liaison and window affairs)
		Budget Management Section		Management of budget compilation and execution, etc.
		Contract Section	Contract Desk	Notification of works orders, contract-related affairs
			Inspection Desk	Inspection of products, etc. after works completion
		Tariff Collection Section		Examination of sewerage charges and collection work, etc.
		Education Section		Planning and implementation of employee technical and business education
	Fixed assets	Sewerage Ledger Section		Preparation and amendment of sewerage ledger (drawings are prepared in duplicate, one each archived in the ledger section and treatment plant/sewer maintenance and inspection section)
		Ledger Management Section		Management and repair of the sewage ledger.
		Asset Management Section		Asset management of the generally sewage
	Design	Planning Section		Creation and review of master plan, collection and management of basic data with population and so on, consistence confirmation with the master plan.
		Utility Coordination Section		Construction of the sewage facilities becomes with the extended period. Therefore, it implements which construction when and it adjusts.
		Design Section	Civil Engineering Desk	Design management of treatment plants, pump stations and sewers civil engineering works
			Architecture Desk	Design management of treatment plant and pump station building works
			Machine Equipment Desk	Management of treatment plant and pump station machine equipment works
			Electrical Equipment Desk	Management of treatment plant and pump station electrical equipment works
	Construction Supervision	Construction Supervision Section	Civil Engineering Desk	Construction supervision of treatment plants, pump stations and sewers civil construction works
			Architecture Desk	Construction supervision of treatment plants, pump stations building works
			Machine Equipment Desk	Construction supervision of treatment plants, pump stations machine equipment works
			Electrical Equipment Desk	Construction supervision of treatment plants, pump stations electrical equipment works
	Water quality testing	Central Test Section		Precision testing work for treatment plants
		Monitoring Section		Monitoring (water quality, air pollution, noise, odor, etc.)
	Treatment plants	General Affairs Section	Accounting Desk	Preparation and execution of budget for equipment and parts, etc., accounting and personnel affairs management, other general affairs
			Asset Management Desk	Treatment plant asset management, archiving and control of completion drawings (drawings, specifications, user manuals, etc.)
			Maintenance Desk	Assign guardsmen around front gates to prevent trespassers. Adopt a 24 hour setup with 2 staff per team and around 4 teams.
		Operation Management Section	Sewage Treatment Operation Management:	Establish a monitoring room in the administration building to conduct operation control of sewage treatment (monitoring, operation control, recording, handing over, liaison and communications). Adopt a 24 hour setup with 2 staff per team and around 4 teams. Conduct monitoring of sludge treatment at night.
			Sludge Treatment Operation Management Desk	Establish a sludge treatment monitoring room near the sludge dewatering equipment to conduct the operation management of sludge treatment facilities. Conduct the main dewatering work during daytime and assign around 2 staff members.
		Maintenance Inspection Section:	Water Treatment Maintenance Desk	Conduct maintenance and inspection work comprising the following activities during the day shift. - Routine inspection and patrol (patrol, troubleshooting, routine work and handover) - Periodic inspection work (preparation of periodic inspection schedule, periodic inspections, lubrication, attendance of outsourced inspections) - Breakdown inspection work (maintenance, inspection, repair and reworking) - Other work (including removal and treatment of screenings, grit and scum, etc.)

			Sludge Maintenance Desk (host treatment plant only)	Conduct maintenance and inspection work comprising the following activities during the day shift. - Routine inspection and patrol (patrol, troubleshooting, routine work and handover) - Periodic inspection work (preparation of periodic inspection schedule, periodic inspections, lubrication, attendance of outsourced inspections) - Breakdown inspection work (maintenance, inspection, repair and reworking) - Sludge removal work

Table 11-1-41 Examination of the Organization required for Maintenance of Sewerage Facilities(2/2)

Organizational setup				Work contents
MWSI/MWCI	Treatment plants	Maintenance Inspection Section	Small Treatment Plant Desk	Small treatment plants of less than 10,000 m3/day capacity are managed based on patrol monitoring. Sludge will be consolidated for treatment in the medium and large treatment plants. Therefore, work contents will be roughly the same as those of the sewage treatment maintenance desk.
		Water Quality Control Section	Sampling Desk	Obtain samples for use in water quality testing.
			Water Quality Test Desk	Conduct the following work during the day shift. - Regular tests Routine tests, inflow and discharge water quality tests, sludge and filtrate tests, recording and reporting work - Instruction for revision of treatment process operation and control conditions
	Sewer Management Department	General Affairs Section	Accounting Desk	Budget preparation and execution for sewers and equipment and parts, etc. at unmanned treatment plants and pump stations, accounting and personnel affairs management, other general affairs
			Asset Management Desk	Asset management at unmanned treatment plants and pump stations, completion documents (archiving and control of drawings, specifications, user manuals, etc.)
			Meter Reading Desk	Reading of usage quantities that provide the basis for tariff collection
			Maintenance Desk	Assign guardsmen around front gates to prevent trespassers. Adopt a 24 hour setup with 2 staff per team and around 4 teams
		Maintenance Inspection Section	Sewer Maintenance Desk	Conduct maintenance and inspection work comprising the following activities during the day shift. - Routine patrol (preparation of work plans and patrol, troubleshooting, routine work and handover) - Periodic inspection work (preparation of periodic inspection schedule (TV, etc.), periodic inspections, attendance of outsourced inspections) - Breakdown repair (maintenance, inspection, repair and reworking) - Other work
			Pump Station Maintenance Desk	Conduct maintenance and inspection work of unmanned pump stations in patrols comprising the following activities during the day shift. - Routine inspection and patrol (patrol, troubleshooting, routine work and handover) - Periodic inspection work (preparation of periodic inspection schedule, periodic inspections, lubrication, attendance of outsourced inspections) - Breakdown repair work (maintenance, inspection, repair and reworking) - Screenings and grit removal work - Other work

Note: Medium and large-scale plants with capacity of 10,000 m3/day or more are managed by permanent staff, and such setups shall be considered for each plant.

(2) Institutional Study

Because of urgent development of sewerage and sanitation systems to be assumed, the organization responsible for sewerage and sanitation services should enforce the functions for construction supervision.

Figure 11-1-29 shows present organization chart of the MWS, and **Figure 11-1-30** proposes organization modifications. Sections shown in red figures mean additional sections.

Figure 11-1-29 Present Organization Chart of the MWSI

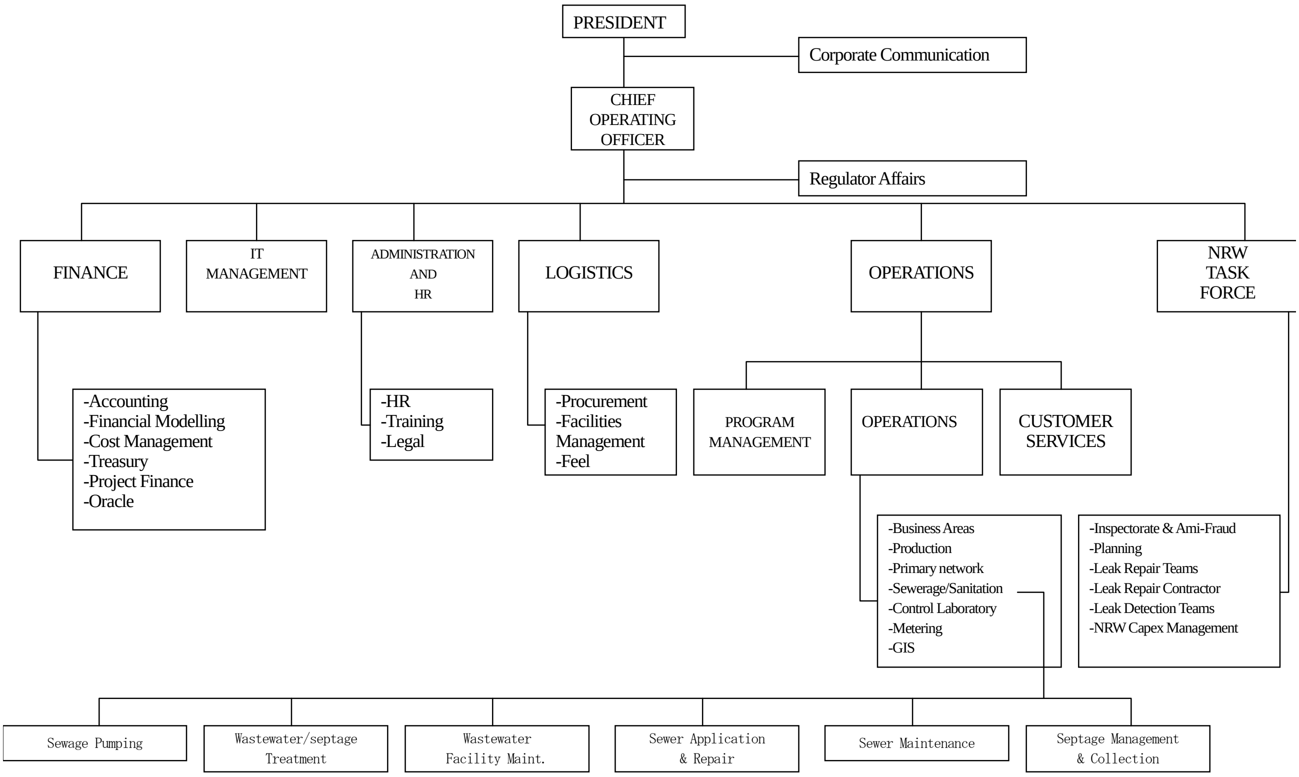
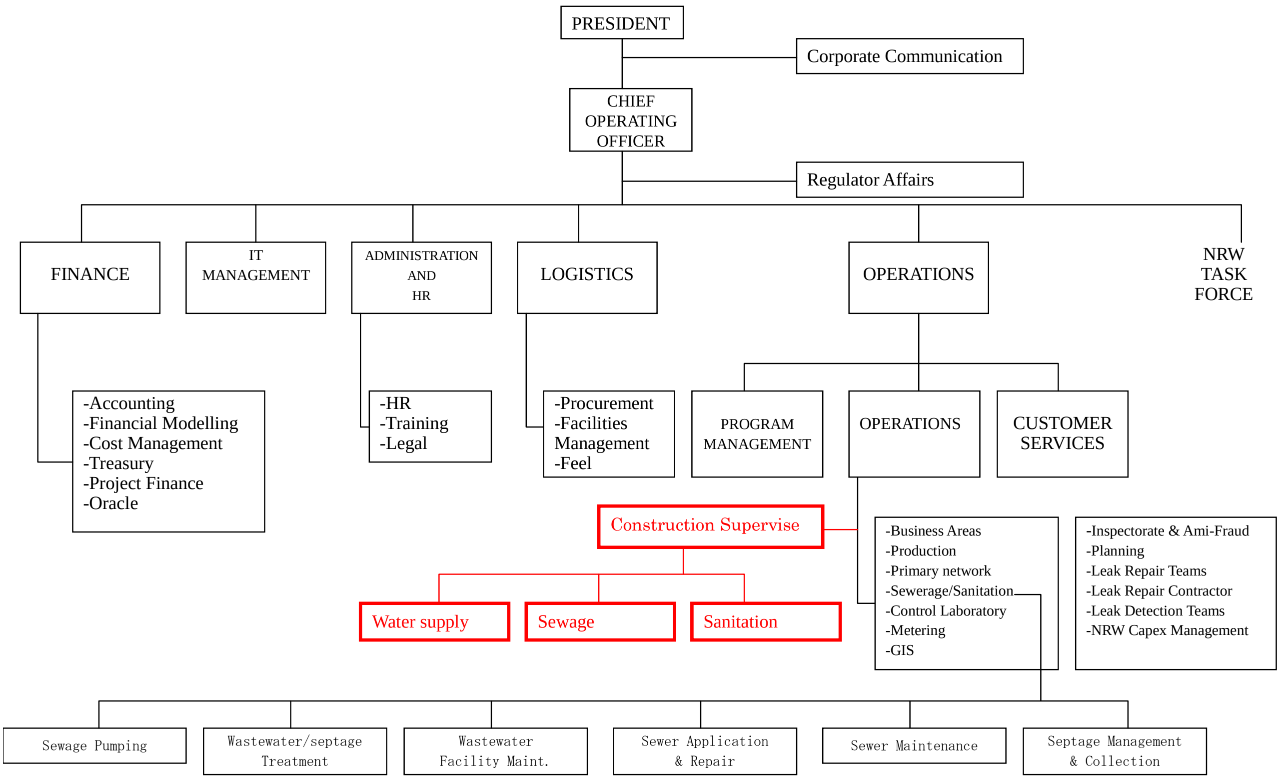


Figure 11-1-30 MWSI Organization Chart Proposed



Note: Thick lines show additional functions proposed

3) Institutional Study of MWCI

MWCI has as the same roles as concessionaire as MWSI. Thus issues and concerns would be same. **Figure 11-1-31**shows present organization chart of MWCI, and **Figure 11-1-32** shows the organization chart proposed. Sections shown in red figures mean additional sections.

Figure 11-1-31 Present Organization Chart of the MWCI

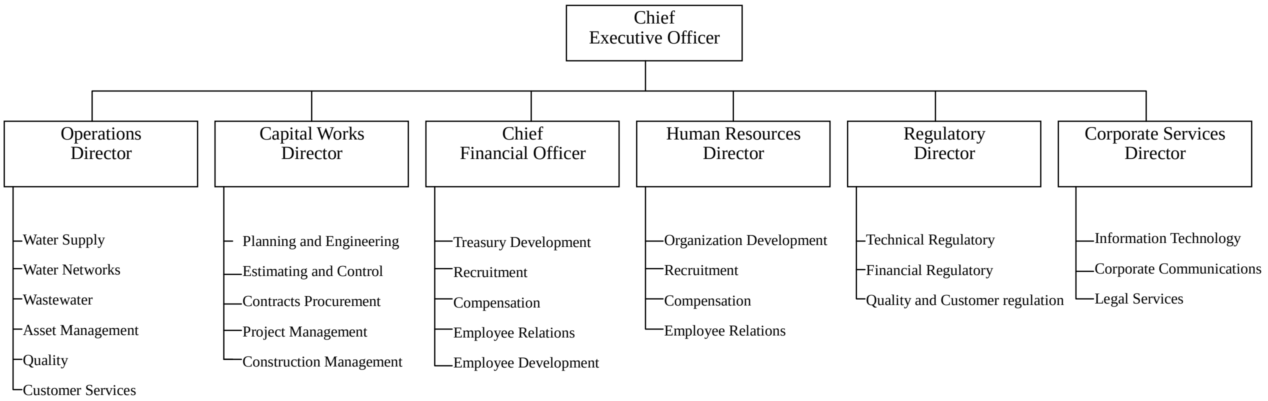
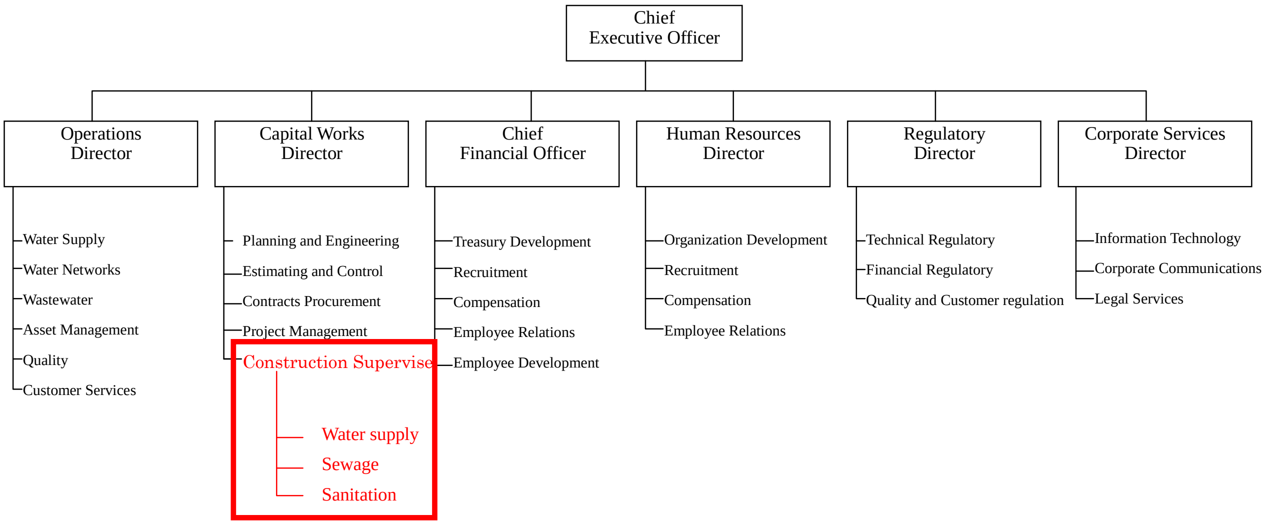


Figure 11-1-32 MWCI Organization Chart Proposed



Note: Thick lines show additional functions proposed

11.2 Training and Education Program

1) MWSS staff training plan

Concerning training of MWSS staff, it is recommended that the kind of plan indicated in **Table 11-2-1** be implemented for staff belonging to the Planning and Overall Managing Office and Asset Management Office recommended under the organizational improvement.

Table 11-2-1 Training Plan of MWSS

Necessary job description	Training contents	Training staff (persons)	Overseas training	Domestic training	Training period (month)	Training cost (peso)
Planning and Overall Managing Office	Learning of project adjustment methods, creating and reconsiders of master plan	2	○		3	1, 300, 000
Asset Managements Office	Learning of asset management methods for the entire sewage system	2	○		3	1, 300, 000
Tariff Study	Enhance the skills in calculating rates and analyzing financial information; gain knowledge on advance techniques in cost service, determination of Appropriate Discount Rate (ADR) asset usefulness and demand profiling	2	○		3	1, 300, 000
Total		6				3, 900, 000

Note : Table 9-2-1and Table 9-2-2

1) At least two members of staff are selected for training from each department to enable the results of training to be stably reflected in the sewerage utility.
2) The training location is set overseas where there is ample experience in treatment plant operation.
3) Training costs are calculated assuming that the training is conducted in Japan.
4) Training costs are calculated as travel expenses + training fees + visit expenses.
5) Travel expenses are set at 50,000 peso/person.
6) Training fees are set as follows upon referring to fees of the Japan Sewage Works Agency.
   - Fixed asset related: 150,000peso/person
   - Planning related: 150,000peso/person
   - Civil engineering related: 95,000 peso/person
   - Machine design: 115,000 peso/person
   - Electrical design: 145,000 peso/person
   - Operation management: 150,000 peso/person
   - Maintenance inspection: 145,000 peso/person
   - Water quality management: 95,000 peso/person
   - Sewer maintenance, design: 255,000 peso/person
7) Visit expenses, including accommodation in Japan, living expenses and travel expenses, are set as 5,000 peso x 90 day = 450,000 peso/person.

2) MWSI/MWCI staff training plan

As the sewage systems becomes larger, shortages of engineers and capacity become especially pronounced in the operation management department. Accordingly, it is necessary to advance training and education according to the following items from the construction phase.

Training and education programs to be required at this stage, that is, at the starting point of sewerage and sanitation system prompt development, the following training and education plans would be necessary.

Table 11-2-2 Training Plan of MWSI/MWCI

Necessary job description			Training contents	Training staff (persons)	Overseas training	Domestic training	Training period (month)	Training cost (peso)
Fixed assets	Sewerage Ledger Section Ledger Management Section Asset Management Section		Preparation and amendment of sewerage ledger, learning of asset management methods for the entire sewage system	2	○		3	1, 300, 000
Design	Planning Section Utility Coordination Section		Learning of project adjustment methods, creating and reconsiders of master plan	2	○		3	1, 300, 000
Design	Design Section	Civil Engineering Desk:	Design of civil engineering works, learning of works management techniques	2	○		3	1, 190, 000
Design	Design Section	Machine Equipment Desk	Design of machine equipment works, learning of works management techniques	2	○		3	1, 230, 000
Design	Design Section	Electrical Equipment Desk	Design of electrical works, learning of works management techniques	2	○		3	1, 290, 000
Treatment plants	Operation Management Section	Water Treatment Operation Management Desk	Learning of operation management techniques (including operation management of pump stations) for each treatment process	2	○		3	1, 300, 000
Treatment plants	Operation Management Section	Sludge Treatment Operation Management Section	Learning of operation management techniques for each sludge treatment process					
Treatment plants	Maintenance Inspection Section	Water Treatment Maintenance Desk	Learning of maintenance inspection work techniques (including maintenance inspection of pump stations)	2	○		3	1, 290, 000
Treatment plants	Maintenance Inspection Section	Sludge Treatment Maintenance Desk	Learning of maintenance inspection work techniques					
Treatment plants	Water Quality Management Section	Water Quality Test Desk	Learning of water quality test techniques necessary for operation management and techniques for giving advice to operation managers	2	○		3	1, 190, 000
Sewer Department	Maintenance Inspection Section	Sewer Maintenance Desk	Learning of design and maintenance inspection work techniques	2	○		3	1, 510, 000
Total				18				11, 600, 000

12. UPDATING THE LATEST MASTER PLANS OF MWSS AND MWSI

The 2005 sewerage and sanitation master plan is the Metro Manila-wide latest master plan and is under updating by a World Bank Consultant Team. Such update takes into consideration the on-ongoing MMSSIP-Phase 2 study as well as the MWSI's sewerage feasibility studies for Imus, Valenzuela and Muntinlupa and Pasay cities. The JICA sewerage and sanitation master plan indicates substantial increase in sewerage coverage compared to the 2005 master plan.

The latest master plan of MWSS (WB, year 2005, Sinclair Knight Merz, Australia) is now under updating by MWSS (WB, TETRA TEC, Berkman International, Australia; Completion period-by February 2012). Regarding sewerage and sanitation development plan in Parañaque and Las Piñas Cities, this JICA sewerage and sanitation implementation plan would be developed by Maynilad. Therefore the latest master plans of MWSS and Maynilad (year 2008) should be consolidated or updated with the JICA project plans.

The followings are the principal diversions from the latest MWSI master plan 2008 to JICA sewerage and sanitation project plans in Parañaque and Las Piñas Cities. These contents have been informed to MWSS to reflect correctly in their updated plan. MWSI is also conducting the feasibility studies for sewerage and sanitation system development in Imus, Muntinlupa, Valenzuera and Pasay Cities, thus MWSI shall consolidate those feasibility studies with JICA project plans and update their master plan reflecting these feasibility studies.

Table 12-1 Summary of JICA Sewerage and Sanitation Development Plan

Citys	Plans	Items	Year of							
			2006	2007	2011	2016	2021	2025	2031	2036
Parañaque	Master Plan (year 2008)	Population	542,411	557,857	592,440	633,857	669,860			
		Sewerage Coverage	0%	0%	8%	16%	30%			
		Sanitation Coverage	28%	48%	45%	50%	70%			
	JICA Plan (updated)	Population	542411	552,660	592,440	633,857	669,860	700,130	724,267	740,871
		Sewerage coverage	0.0%	0.0%	0.0%	59.2%	62.9%	64.1%	102.3%	100.0%
		Sanitation coverage	28%	48%	45%	40.8%	37.1%	35.9%	0.0%	0.0%
Las Piñas	Master Plan (year 2008)	Population	526,620	535,280	562,490	591,540	615,070			
		Sewerage Coverage	0%	0%	9%	17%	37%			
		Sanitation Coverage	31%	48%	41%	44%	63%			
	JICA Plan (updated)	Population	526,620	532,330	562,490	591,540	615,070	633,127	645,662	652,737
		Sewerage coverage	0.0%	0.0%	0.0%	0.9%	64.1%	103.5%	101.5%	100.0%
		Sanitation coverage	31%	48%	41%	44%	35.9%	0.0%	0.0%	0.0%

13 FINANCIAL-ECONOMIC ANALYSIS

This chapter aims to determine the financial and economic feasibility of the proposed Las Piñas and Parañaque sewerage project which will serve more than one (1) million residents. The proposed Project forms part of the revised 2008 Business Plan of MWSI. The design service coverage takes into consideration the full sewerage coverage in these MWSI concession areas by 2036.

The Philippine Government does not provide significant grants for sewerage systems. It cannot afford to pay for the major cost of such projects because of the huge capital investment. Annual investment in sewerage on a national level is a very small percentage of the total investment in water supply. Since 1970, for every PhP97 spent on water, only PhP3 has been spent on sanitation and sewerage (Data Source: 2005-2025 Sewerage and Sanitation Master Plan for Metro Manila).

Investments for this proposed sewerage project for the cities of Las Piñas and Parañaque will come from a loan from the Japan International Cooperation Agency (JICA) with equity from the MWSI. Two (2) financial schemes are being considered and assessed to determine which is the most applicable scheme. Moreover, eight (8) technical design options of different investment estimates, technical soundness and service coverage were originally considered but only **Option 8** which is the recommended least cost option/technical design was subjected to financial and economic evaluation.

A. FINANCIAL CAPACITY AND FINANCIAL VIABILITY ANALYSIS

13.1 Financial Capacity Assessment

13.1.1 The Maynilad or MWSI (Maynilad Water Services, Inc.)

Recent audit by a competent external auditor (Sycip, Gorres and Velayo or the SGV) in 2009 generally found the Maynilad financially healthy. The 2010 unaudited financial figures were limited to October 2010 during the period of assessment. Some of the Company's positive financial performance is mostly reflected by an increasing trend of comprehensive income, operating revenues and others as shown in the tables below:

Table 13-1: Summary of MWSI's Comprehensive Income

Item	Income per Year End (in PhP '000)		
	2009	**2008**	**2007**
Net income for the year	2,824,626	1,994,140	1,666,351
Other comprehensive income	-	-	-
Total comprehensive income for the year	**2,824,626**	**1,994,140**	**1,666,351**

Source: 2009 Independent Auditor's Report (SGV&Co./Ernst &Young)

Table 13-2 (1/2): Summary of MWSI's Operating Revenues

Income Source	Income per Year End (in PhP '000)		
	2009	2008	2007
Water services	2,824,626	1,994,140	1,666,351
Sewerage services	1,623,595	1,386,955	1,297,705
Other services	419,442	438,227	465,976
Total operating revenue	**2,824,626**	**8,244,860**	**7,377,042**

Source: 2009 Independent Auditor's Report (SGV&Co./Ernst &Young)

In terms of the Maynilad's annual expense for the 2007-2009 audited financial years, an increasing trend is observed with an average 10 percentage points per year. The negative balance in the 2009 Audit may be offset during the rebasing done every three years and being adopted by the Concessionaires (i.e. MCW and MWSI) of the MWSS. Please see Table 13-2 (2/2) below for the summary annual expense of the Company:

Table 13-2 (2/2): Summary of MWSI's Annual Expense

Year	Revenues	Expense	Balance
2007	7,377,042,000.00	3,988,000,000.00	3,389,042,000.00
2008	8,244,860,000.00	4,532,000,000.00	3,712,860,000.00
2009	2,824,626,000.00	4,974,000,000.00	(2,149,374,000.00)

Source: 2009 Independent Auditor's Report (SGV&Co./Ernst &Young)

13.1.2 Commitments and Obligations relative to the Concession Agreement

With respect to significant commitments under the Concession Agreement are the *Payment for Concession Fees* and *Posting of Performance Bond*. The latter is to secure the performance of its obligations under certain provisions (Section 13.9) of the concession agreement. The aggregate amount is obtainable in one or more installments under such performance bond during the rate rebasing period. The said aggregate amount during the last rebasing period has been adjusted to USD30 million until the expiration date. But with the extension of the concession agreement, the present minimum level of the performance bond will be increased to USD90 million for the third rebasing period in 2012. Below are a few of Maynilad's commitments and obligations under the Concession:

Operating Lease Commitments – MWSI leases office spaces and branches which are renewable under certain terms and conditions. The total expense for the operating leases amounted to PhP77.2 million in 2009, PhP66.7 million in 2008 and PhP90.1 million in 2007.

Assets Held in Trust – MWSI has the right to use any items of the inventory-owned by the MWSS to effectively carry out its responsibility under the concession agreement. The obligation to return the same inventory items at the official termination of the concession period, in kind or in value¸ at its current rate, are subject to consumer price index (CPI) adjustments.

Moreover, MWSI has been granted the right to operate, maintain in good working order, repair, decommission, as well as refurbish any movable property that are needed to provide the water and sewerage services under the concession agreement. MWSS shall retain the legal title to all movable property in existence of the commencement date. Upon expiration of the economic life of any movable property, it shall be returned to MWSS in its current condition with no charge.

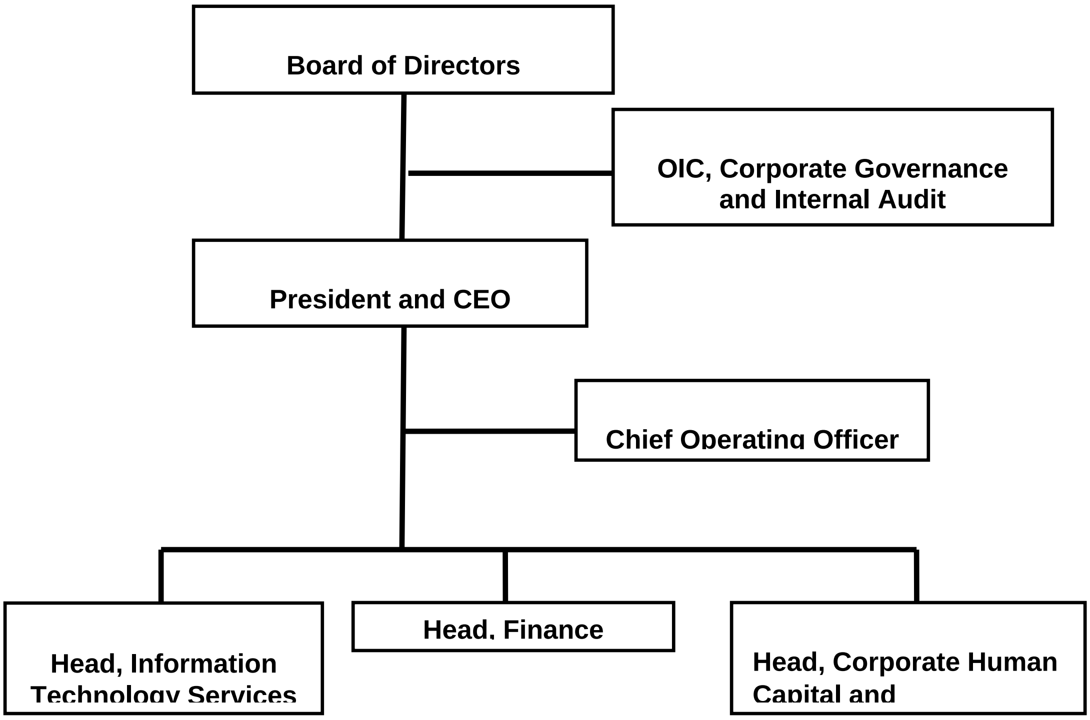
13.2 The MWSI Organizational Structure

The structure of Maynilad (or MWSI) is created consistent with its vision of responsibly providing water and wastewater services to the west zone of the greater Manila area. With respect to implementation of projects the finance and operation sub-structures of Maynilad ensure that these projects are implemented well both in the physical and financial paradigms.

13.2.1 Finance

The finance-related concerns of the Maynilad are a responsibility of the finance arm which is structured (with names of officers/heads) as shown in Figure 13-1. Relative to financing or equity provision of funds for projects, it is the Finance Services Head oversees that the concerns are addressed appropriately.

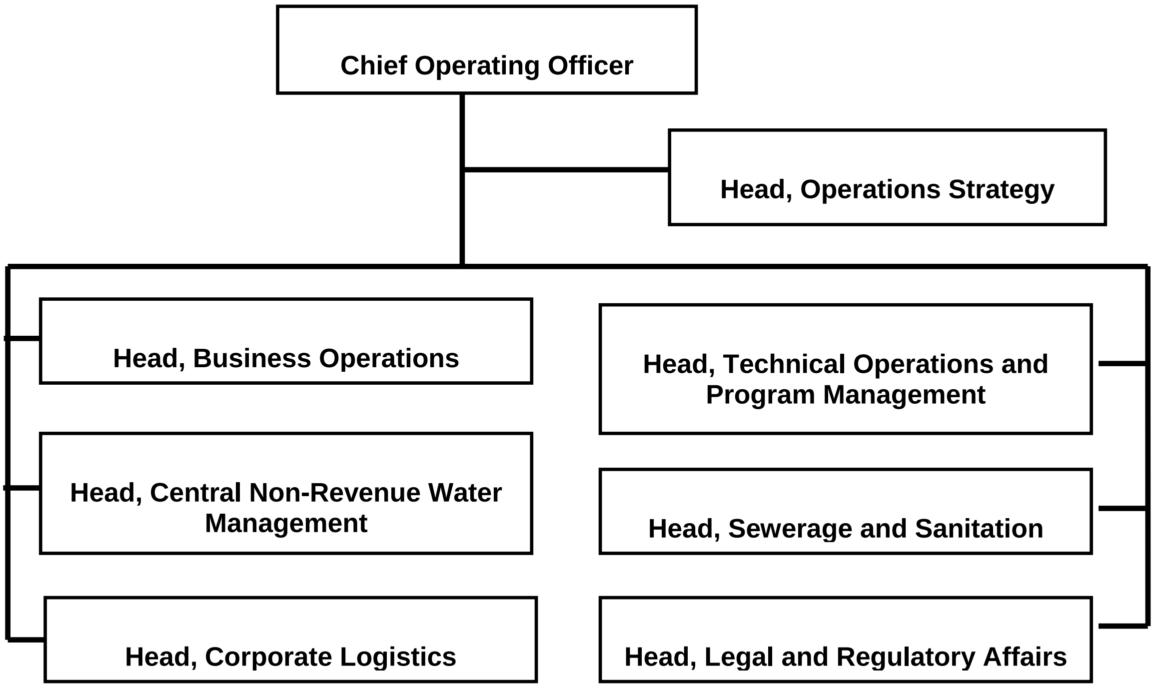
Figure 13-1. Organizational Structure – MWSI Management and Finance



13.2.2 Operations

Other than the finance side of the Maynilad, its operations and management are equally important of which is organizationally structured (with names of officers/heads) as shown in Figure 13-2. Also under the supervision of the Chief Operating Officer, the construction, implementation and monitoring of projects are the specific responsibilities of the Technical Operations and Project Management Department and the Sewerage and Sanitation Department. The former handles the construction of the projects while the latter takes care of the operation/implementation side of the projects.

Figure 13-2. Organizational Structure – MWSI Finance



13.3 The Proposed Investment

13.3.1 Investment (Capital or CAPEX) and Operating (OPEX) Costs

The proposed construction of the Las Piñas and Parañaque Sewerage and Sanitation Project will involved the development of seven (7) sewage treatment plants with accessories and will be done in four (4) development phases. The cost of the Project is estimated at Php 24.775 billion with operating costs of Php 70 million, Php 60 million, Php 54 million and Php 30 million from Phase One (1) to Phase Four (4), respectively. The table on the succeeding page highlights the base costs of the proposed investment as well as the operating costs.

The operating cost is estimated to have the following proportions /cost items as shown in Table 13-3 below.

Table 13-3: Cost Items Included in the Operational Expense

Cost Items Included in the OPEX	Estimated Portion from Total OPEX (in %)
Pumping	**25.45**
STP Power	**54.44**
Chemicals	**13.78**
Dewatering	**2.72**
Personnel	**1.49**
Sludge Disposal	**0.15**
Rental	**1.96**
All OPEX	**100.00**

Data Source: FSR on West Sub-Catchment Sewerage System

Table 13-4: Project Based Cost Estimates and Operating Costs

Phase (A)	Service Coverage (B)	Service Commencement (C)	**ODA Loan in Php**			**Equity in Php**				**TOTAL INVESTMENT (K)**	**Annual OM (L)**
			Procurement/ Construction (D)	Consulting Services (E)	Total ODA (F)	Procurement/ Construction (G)	Land Procurement (H)	Admin Cost (I)	Total Equity (J)		
Phase 1	427,932	2,017	5,598,625,500	360,887,850	5,959,513,350	573,692,500	89,603,580	375,108,511	1,038,404,591	6,997,917,941	70,000,000.00
Phase 2	387,567	2,021	4,549,143,000	361,480,607	4,910,623,607	773,806,000	420,972,200	340,106,790	1,534,884,990	6,445,508,597	60,000,000.00
Phase 3	399,740	2,015	5,416,480,000	361,480,561	5,777,960,561	-	1,526,318,200	390,052,801	1,916,371,001	7,694,331,562	54,000,000.00
Phase 4	141,627	2,029	3,040,276,000	361,480,561	3,401,756,561	-	-	235,743,419	235,743,419	3,637,499,980	30,000,000.00
	1,356,866		**18,604,524,500**	**1,445,329,580**	**20,049,854,080**	**1,347,498,500**	**2,036,893,980**	**1,341,011,520**	**4,725,404,000**	**24,775,258,080**	**214,000,000.00**
Percentages to Total		D	93%	G	29%	I	28%		ODA	81%	
		E	7%	H	43%				Equity	19%	

Note: D means that Procurement/construction costs is 93% of total ODA (F), E means that Consulting Services is 7% of total ODA
G means Procurement/Construction costs is 29% of total Equity (J), H means Land Procurement cost is 43% of total Equity while I is 28% of total Equity
ODA is 81% of total Investment while Equity is 19% of total investment
Figures are based on 2011 prices.

13.3.2 Investment (Capital) Plan

The proposed investment has four (4) development phases which require respective costs. Below is the table showing the annual cost schedules.

Table 13-5: Project Costs Schedule

Phase	TOTAL CAPEX In Php	Year	Annual CAPEX in Php
Phase 1	6,997,917,941	2013	229,532,457
		2014	1,217,337,541
		2015	4,508,231,353
		2016	1,042,816,590
Phase 2	6,445,508,597	2017	574,376,057
		2018	965,567,132
		2019	3,960,207,346
		2020	945,358,062
Phase 3	7,694,331,562	2021	1,724,506,137
		2022	883,696,518
		2023	4,121,083,638
		2024	965,045,270
Phase 4	3,637,499,980	2025	181,022,934
		2026	537,265,678
		2027	2,328,584,166
		2028	590,627,202
TOTAL	**24,775,258,080**		**24,775,258,080**

13.3.3 Impact on Tariff and Projected Revenues by Phase and Overall Project

Based on computations, the proposed investment will entail an average increase of Php 0.36 per one thousand cubic meters (or one liter) which will result to an environmental charge (16% of total basic charge) of Php 62.13 and Php77.66 for sewer charge (20% of total basic charge). Table 13-6 shows the computation on tariff.

Table 13-6. Project Impact on Tariff

Construction Phase	Year of Service Commitment	Service Population	Water Demand Projection		OM Cost per Year Cumulative MP (A)	Construction Cost Cumulative MP (B)	Additional Monthly Cost ((A+B)/40)/12/C	Environmental Charge of 20% P/L/mo.	Total Charge Additional for Sewerage P/L/mo
			L/pcp	ML/mo (C)					
Phase 1	2017	427,932	180	2,311	697	6249	0.031	0.006	0.037
		1,237,607		6,683			0.011	0.002	0.013
Phase 2	2021	815,489	186	4,538	1295	11926	0.029	0.006	0.035
		1,284,930		7,151			0.019	0.004	0.022
Phase 3	2025	1,215,239	186	6,763	1839	18640	0.028	0.006	0.034
		1,321,618		7,355			0.026	0.005	0.031
Phase 4	2029	1,356,866	186	7,551	2138	22604	0.030	0.006	**0.036**
		1,356,866		7,551			0.030	0.006	**0.036**

Computation on the water charge for the average first 30 cubic meter consumption of a household is shown below:

Table 13-7. Computation of Project Impact on Water Tariff

Project Impact on Water Tariff (Phases 1-4)			
Basic Tariff	Water Consumption in cu m	Rate per cu m in P	Amount (P)
First 10	10	8.57	85.68
Second 10	10	10.45	104.50
Next 20	10	19.81	198.10
Monthly Bill	30		388.27
Tariff per cu m			12.94
Addl Charge due to Project			**0.036**
Total Basic Charge			388.30
FCDA			4.7
Environmental Charge (16%)			62.13
Sewer Charge (20%)			77.66
Maintenance Service Charge			1.5
Total Current Charge Before Tax			534.29
Add Vat of 12%			64.12
Total Amount Due			**598.41**

Based on Table 13-7, the projected revenues per phase are shown in Table 13-8 below:

Table 13-8. Projected Annual Water Revenues (in Php) from the Project

Phase	Start of Service Commitment	Revenue based on Environmental Charge (16% of basic water charge)	Revenue based on Environmental plus Sewer Charges (combined 36% of basic water charge)
Phase 1	2017	1,367,352,780	3,076,464,245
Phase 2	2021	1,238,376,225	2,786,274,497
Phase 3	2025	1,277,272,090	2,873,787,932
Phase 4	2029	452,534,683	1,018,176,723
	Total	4,335,535,778	9,754,703,397

13.3.4 Financing Plan for the Proposed Investment

Table 13-3 highlights the ODA (81%) and equity (19%) portions of the proposed investment. If the JICA ODA loan facility will be availed by Maynilad (MWSI), then the ODA loan amount is Php 20.049 billion consists of the procurement/construction and consulting services costs. Maynilad, on its part, will counterpart an amount of Php4.725 billion which comprised of procurement/construction, land procurement and admin costs.

13.3.4.1 Possible Financing Schemes/Options

As earlier mentioned in this Chapter, there are two (2) financing options being considered in this investment: Option 1 is the Two-Step Loan (TSL) which is channeled through a government financing institution (GFI) while the other Option (2) is direct loan from the JICA ODA loan facility which can only be availed by a government entity like the MWSS. In either case, the Maynilad will be the executing agency/organization while either the GFI (Option 1) or MWSS (Option 2) will act as borrower, please refer to Figure 13-3

Under Financing Scheme 1 or the TSL, two (2) GFIs are considered in the Assessment to act as the borrower of the loant: (i) the Land Bank of the Philippines or LBP and the (ii) Development Bank of the Philippines or DBP. The matrix below describes the LBP and DBP respectively:

Table 13-9: Narrative Descriptions of the Government Financing Institutions considered under Fund Scheme 1

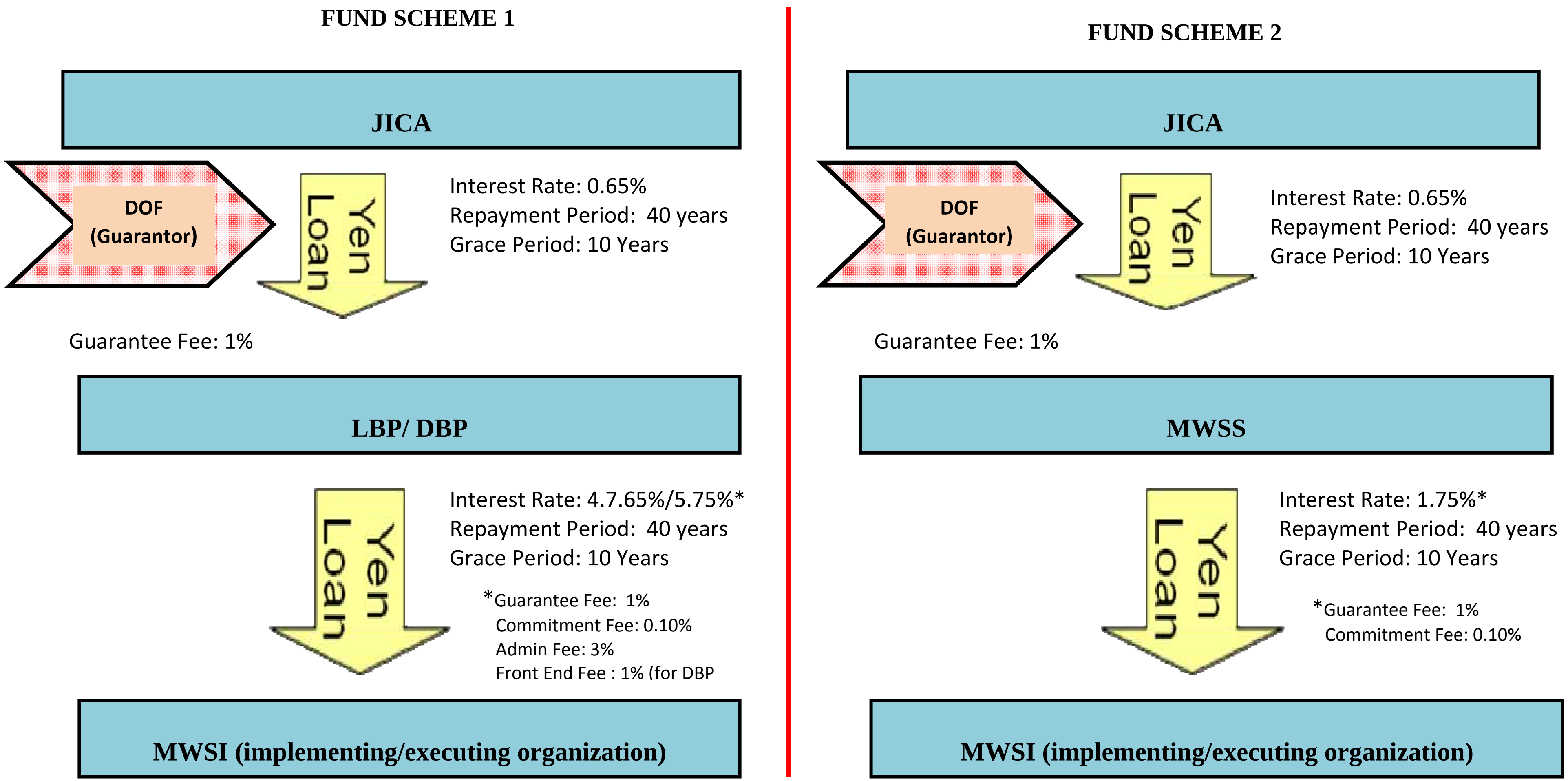
Government Financing Institution	Description
Land Bank of the Philippines (LBP or LANDBANK)	The Land Bank of the Philippines is a government financial institution that strikes a balance in fulfilling its social mandate of promoting countryside development while remaining financially viable. This dual function makes LBP unique. The profits derived from its commercial banking operations are used to finance the Bank's developmental programs and initiatives. From its initial role as the financing arm of the agrarian reform, LBP has evolved into a full-service commercial bank. But the essence of its existence has not changed at all – and that is to make the countryside continuously throb with life. Over the years, LBP has successfully managed this tough balancing act as evidenced by the continued expansion of its loan portfolio in favor of its priority sectors: the farmers and fisherfolk, small and medium enterprises and microenterprises, livelihood loans and agribusiness, agri-infrastructure and other agri- and environment-related projects, socialized housing, schools and hospitals. Today, LBP is by far the largest formal credit institution in the rural areas. Its credit delivery system is able to penetrate a substantial percentage of the country's total number of municipalities. LBP or LANDBANK also ranks among the top five commercial banks in the country in terms of deposits, assets, loans and capital. <u>2009 Financial Highlights</u> Based on its 2009 Annual Report, LBP had a Total Resource of Php 513.8 billion, Loan portfolio (net) of Php 213.46 billion and Investments (net) 174.56 billion. In terms of revenues, the gross

	was Php31.2 billion with Interest Income on Loans worth Php14.4 billion and Income on Investments valued at Php11.3 billion. In terms of the LBP 2009 Gross Loan Portfolio, total portfolio amounted to Php 195.2 billion of which 68% or Php132.8 billion went to the priority sector loans. Of the total priority sector loans, three percent (3%) or Php4.7 billion went to financing of environment-related projects which included water and waste water projects. It was noted that the share of the priority sector loans in the LBP Loan Portfolio increased from 35.9% in 2000 to 68% in 2009. <u>Foreign Borrowings (as of 31 December 2009)</u> Of foreign borrowings, Php30,156.50 million represents bills payable to multilateral and bilateral funding agencies such as World Bank, Asian Development Bank, Japan International Cooperation Agency (JICA) and Kreditanstalt Fur Wiederaufbau. Foregin borrowings relent in local currency are provided with foreign exchange (FX) risk cover by the Philippine Government. Of the said amount the National Government has provided foreign exchange risk cover (FXRC) on the Php23,530.34 million which has a historical value of Php18,770.72 million. LBPs foreign borrowings from multilateral and bilateral agencies have maturities ranging from 15 to 40 years.
Development Bank of the Philippines (DBP)	DBP is the premier government financial institution dedicated to supporting the national government's key development programs. It has diligently put in place a comprehensive framework to spur progress in vital sectors of the economy focusing on four major areas - infrastructure and logistics; social services; micro, small and medium enterprises; and environment. DBP works hand-in-hand with key players from both the private and public sectors such as local government units, national agencies, private corporations, multilateral and bilateral lending institutions, private banks, rural banks, cooperatives, amongst others, in carrying out its various development programs and initiatives. Under its Environmental related initiatives include the following: Priority Projects Water Supply • Resource development, transmission, distribution and treatment. • Investment for Non-Revenue Water reduction.

	Water Sanitation • Development of sanitation services/facilities <u>2010 Financial Highlights</u> Based on 31 December 2010 Balance Sheet, the DBP has Total Assets valued at Php 297.295 billion with Total Liabilities and Stockholders' Equity worth Php256.920 billion and Php40.374 billion, respectively. Under the Liabilities, bills payable for ODA (overseas development assistance) amounted to Php39.589 billion. On DBP's contingent accounts, amount of Guarantees issued was about Php822.869 million. . Non-performing Loans (NPL) was valued at Php4.708 billion which is 3.71 percent of total loan portfolio.

Data Source/s: Websites and Annual Reports of the LBP and DBP

Figure 13-3: Possible Financing Options/Schemes



Note: Repayment period 40 years is in the case of selection of the longest repayment period.

Relative to Financing Scheme 2, the Manila Waterworks and Sewerage System (or MWSS) will act as borrower and the Maynilad or MWSI will be the implementing/executing organization. This is so because of the JICA bilateral agreement which can only extend loan assistance to government agencies, government-owned corporations and government financing institutions. Below is a matrix describing the MWSS. Please note that the MWSS did not disclose its relevant financial data as of feasibility report preparation.

Table 13-10: Brief Narrative Description of the Metropolitan Waterworks and Sewerage System (MWSS)

Metropolitan Waterworks and Sewerage System (MWSS)	Description
Privatization	MWSS was privatized in 1997. It is a government corporation responsible for the water supply and sewerage disposal in the greater Metro Manila area. The privatization was a policy decision to provide adequate water supply and sewerage services to the largest urban center in the country and the desire to end government subsidies to its operations.
Concession Agreement	The concession agreement transfers the service obligations of the MWSS to its private partners. To meet said obligations, the private partners have the right to provide water, sewerage and sanitation services. MWSS transfers the custody of its facilities to its private partners but will still remain as MWSS properties. The private partners are also responsible for the maintenance of the water supply, sewerage and sanitation facilities as well as the as well as the MWSS debt arising from capital investments allocated to them. Servicing of said debt is through the payment of annual concession fees by the private partners to the MWSS.
Regulatory Framework	MWSS functions as a regulatory entity through its Regulatory Office (MWSS RO) . Service obligations of the MWSS are assumed by its private concessionaires (i.e. MWSI and MWCI) set in the agreement in the form of service target for water supply, sewerage and sanitation, to be completed within specified dates during the concession period. Moreover, the private concessioners are allowed to charge user charger to recover their operating, maintenance and capital expenditures and agreed rate of return of these expenditures which they termed as appropriate discount rate (ADR).
MWSS Financial Ceiling	Borrowing Ceiling of MWSS Available balance: PhP Php3 B PhP 76 M Foreign USD 600 USD M 408 USD M

Below is Figure 13-4A and 13-4B which present the existing organizational structures of MWSS Corporate Office and the LBP/DBP. Note that the financial control and monitoring of MWSS and its concessionaires is the responsibility of the Managerial Finance and Budget Division (yellow box) whiles the Project management and monitoring is handled by the Project Management Division (blue box), and yellow box in LBP/DBP structures are responsible fund lending process and project financial monitoring to MWSI Financial Sector (refer Figure 13-5).

Figure 13-4A. Organizational Structure of the MWSS Corporate Office

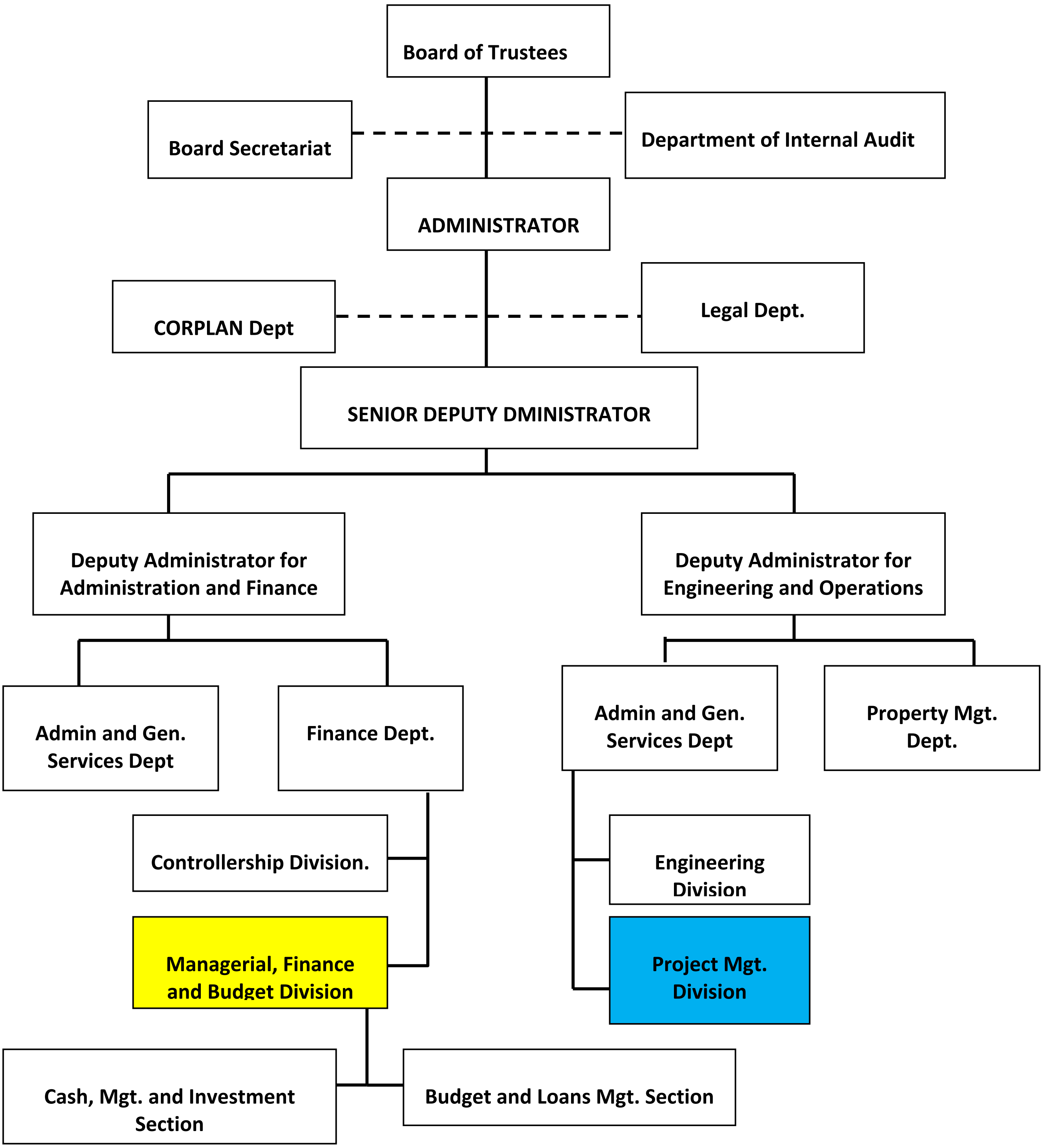


Figure 13-4B. Organizational Structures of the LDP/DBP

Land Bank of The Philippines Organization Structure

- Board of Directors
  - Trust Banking
  - Risk Management
  - Internal Audit
  - Corporate Goernance
  - Agri-Agra Social Concerns
  - Office of Compliance Management
  - Office of the Corporate Secretary
- President and CEO
  - Strategic Planning
  - Legal Services
  - Technology Management
  - Corporate Affairs Department
  - Physical Security Office
  - Agrarian & Domestic Banking Sector
    - Branches Group
    - Landowners Conpebsation & Assistance
    - Consumer & e-Baning
    - Program Management
    - Field Unit Support
  - Operations Sector
    - Banking Operations
    - Banking Service
    - Control Ship
  - Corporate Services Sector
    - Facilities & Procuement
    - Human Resources Management
    - Provident Fund Office
  - Institutional Banking & Subsideries Sector
    - Program Lending
    - Account Management
    - Treasury
    - Investment Banking & Special Assets
    - OFW Remittance

Development Bank of The Philippines Organization Structure

- Board of Directors
  - Office of Chaiman
- President and CEO
  - Compliance Monitoring
  - Strategic Planning & Research
  - Corporate Affairs
  - Trust Services
  - Office of the Corporate Secretary
  - Office of the Legal Counsel
  - Operating Office
    - Credit Policy Supervision
    - Information Technology
    - Internal Audit
    - Process Management
    - Risk Management
    - Property & Services Management
    - Human Resources Management
  - Development Sector
    - Program Development I
    - Program Development II
    - Program Evaluation
  - Operations Sector
    - Accounting
    - Transaction Processing
    - Credit & Appraisal Management
    - Disbursement & Securities Management
    - Asset Management-ROPA
  - Marketing (Head Office) Sector
    - Marketing Department I - Retail/Wholesale
    - Marketing Department II
    - Investing Banking
    - Capital Markets Development
    - Remedial Management
  - Branch Banking Sector
    - Marketing
    - Cash Management
    - Central Cleaning & ATM Operations
    - WB-Microfinance Small & Medium Enterprise
    - Business Development & Marketing II (Rural Banks)
    - Factoring
  - Finance Sector
    - Treasury
    - Remittace Center
    - Fund Sourcing

13.3.4. 2 Terms and Conditions for the Two Possible Financing Schemes/Option

The respective possible financing schemes have their terms and conditions in availing the loans. The table below presents the terms and conditions of the GFIs like LBP and DBP for Option (Fund Scheme) 1 and of the JICA direct loan facility for Option (Fund Scheme) 2.

Table 13-11: Terms and Conditions under the Financing Options

Financing Option		Terms and Conditions	Remarks
Two Step Loan thru the Government Financing Institution OPTION 1	Land Bank of the Philippines (LBP)	Interest+Commitment: 0.65% Admin Fee:: 3% Guarantee Fee: 1% **Total Charges: 4.75%** Grace Period: 10 years Repayment Period: 40 years	Payment within Concession Period
	Development Bank of the Philippines (DBP)	Interest+Commitment: 0.65% Admin Fee:: 3% Front End Fee: 1% Guarantee Fee: 1% **Total Charges: 5.75%** Grace Period: 10 years Repayment Period: 40 years	Payment within Concession Period
Direct Loan from JICA thru the MWSS OPTION 2	Option 2.1 (Standard)	Interest : 0.65% Commitment Charge:0.10% Guarantee Fee: 1% **Total Charges: 1.75%** Grace Period: 10 years Repayment Period: 40 years	These are the four Options applicable preferential terms for lower-middle income countries like the Philippines with GNI per Capita (2008) of USD 976-USD 1,855. All four options are beyond the 2037 concession period.
	Option 2.2	Interest : 0.55% Commitment Charge:0.10% Guarantee Fee: 1% **Total Charges: 1.65%** Grace Period: 10 years Repayment Period: 30 years	
	Option 2.3	Interest : 0.50% Commitment Charge:0.10% Guarantee Fee: 1% **Total Charges: 1.60%** Grace Period: 6 years Repayment Period: 20 years	
	Option 2.4	Interest : 0.40% Commitment Charge:0.10% Guarantee Fee: 1% **Total Charges: 1.50%** Grace Period: 5 years Repayment Period: 15 years	

Note: Government Guarantee Fee of 1% of total loan amount is always included in the computation regardless of type of financing options.
Data Sources: Officers of respective banks and JICA Website

13.4 Results of the Financial Viability Analysis

The viability computations were done and yielded the following indicators (presented in Table 13-12) based on the assumptions discussed in the earlier sections of this Chapter. Moreover, the financial hurdle rate used in the analysis is the 9.3% appropriate discount rate (ADR). This means that the respective options which yielded the financial IRR (FIRR) of 9.3% and above are considered viable. Relative to the result of the analysis, the direct loan financing option is viable in all conditions/scenarios. It is noted though that Phases 3 and 4 of the proposed Project sometimes reflect non-viability. The shortness of the grace and payment period relatively has an effect to the non-viability. It should be noted that the longest period of analysis is the Option 1 (Standard preferential terms) under the Direct Loan Scheme which is a combined 10 years grace period and 40 years repayment. The shortest on the other hand is the 5 years grace period and 15 years repayment for both GFIs and Option 4 of the Direct Loan Scheme. Please refer to Annexes 13. A to L for the detailed computations of the various financing scenarios.

Table 13-12A: Financial Viability Results

		Financial IRR		Net Present Value (in PhpBillion)	
		Under Tariff based on Envi Charge Only	Under Tariff based on Envi + Sewer Charges	Under Tariff based on Envi Charge Only	Under Tariff based on Envi + Sewer Charges
Fund Scheme 1 Two Step Loan thru the GFI	LandBank	Phase 1 9% Phase 2 9% Phase 3 7% Phase 4 5% Overall 10%	Phase 1 25% Phase 2 25% Phase 3 19% Phase 4 16% Overall 23%	Phase 1 (0.211) Phase 2 (0.107) Phase 3 (1.923) Phase 4 (1.728) Overall (0.844)	Phase 1 13.624 Phase 2 12.619 Phase 3 5.653 Phase 4 2.813 Overall 26.620
	DBP	Phase 1 6% Phase 2 10% Phase 3 8% Phase 4 4% Overall 9%	Phase 1 24% Phase 2 24% Phase 3 20% Phase 4 15% Overall 23%	Phase 1 (1462) Phase 2 (0539) Phase 3 (0941) Phase 4 (2.808) Overall (0.529)	Phase 1 14.174 Phase 2 13.072 Phase 3 11.985 Phase 4 2.499 Overall 29.174
Fund Scheme II Direct Loan thru the MWSS	Standard	Phase 1 14% Phase 2 13% Phase 3 11%.. Phase 4 6% Overall 13%	Phase 1 30% Phase 2 28% Phase 3 25% Phase 4 15% Overall 28%	Phase 1 3.557 Phase 2 1.884 Phase 3 1.551 Phase 4 (1.522) Overall 5.822	Phase 1 16.915 Phase 2 13.123 Phase 3 14.478 Phase 4 3.057 Overall 35.785
	Option 1	Phase 1 14% Phase 2 13% Phase 3 11% Phase 4 5% Overall 12%	Phase 1 30% Phase 2 28% Phase 3 25% Phase 4 15% Overall 29%	Phase 1 2.691 Phase 2 1.592 Phase 3 1.122 Phase 4 (1.656) Overall 4.818	Phase 1 16.139 Phase 2 13.135 Phase 3 13.733 Phase 4 2.808 Overall 34.925
	Option 2	Phase 1 11% Phase 2 11% Phase 3 8% Phase 4 3% Overall 10%	Phase 1 28% Phase 2 27% Phase 3 23% Phase 4 17% Overall 26%	Phase 1 0.839 Phase 2 0.769 Phase 3 (0.502) Phase 4 (1.519) Overall 1.631	Phase 1 12.924 Phase 2 11.714 Phase 3 10.786 Phase 4 2.481 Overall 30.194
	Option 3	Phase 1 8% Phase 2 8% Phase 3 5% Phase 4 -2.7% Overall 9%	Phase 1 26% Phase 2 26% Phase 3 22% Phase 4 15% Overall 26%	Phase 1 (0.673) Phase 2 (0.494) Phase 3 (1.856) Phase 4 (2.072) Overall (28.04)	Phase 1 10.008 Phase 2 9.180 Phase 3 8.123 Phase 4 1.463 Overall 27.003

Table 13-12B: Financial Viability Results – JICA Computations

	Financial IRR		Net Present Value (in PhpBillion)	
Note: JICA computations exclude interest and other charges. This renders same computation results across the two (2) funding schemes/options. Refer to Annexes N and O for the computations by Phase and Overall Project.	Under Tariff based on Envi Charge Only	Under Tariff based on Envi + Sewer Charges	Under Tariff based on Envi Charge Only	Under Tariff based on Envi + Sewer Charges
	Phase 1 15% Phase 2 15% Phase 3 13% Phase 4 10% Overall 15%	Phase 1 31% Phase 2 30% Phase 3 26% Phase 4 22% Overall 30%	Phase 1 4589 Phase 2 4044 Phase 3 3183 Phase 4 0.137 Overall 9.043	Phase 1 18.425 Phase 2 16.576 Phase 3 16.108 Phase 4 4.926 Overall 39.510

The investment for sanitation and sewerage projects, from the point of view of basic need of the society, is a venture of high economic benefits but generally not on financial profits. But in terms of returns or recovery of investments, it may not necessarily be viable due to high investment cost of capital for this type of project. The return of investments is expectedly low and may take some time to fully recover the incurred investment costs, notwithstanding the entailed cost of operation that will ensure the smooth implementation of the sanitation and sewerage services in the covered areas of the MWSS.

On the part of the Maynilad, as a concession partner, the proposed sanitation and sewerage project for the cities of Las Piñas and Parañaque will impact on its financial situation in terms of increase in cost in capital or equity payments and related charges as interest and guarantee payments/ performance bond during the development or construction phase. Maynilad (MWSI), as the Company, can compensate for the 'shortage' from other financial sources (i.e. short term investments, postponed planned investments of other water or sewerage projects, etc.) or during rate rebasing done every five (5) years.

13.5 Possible Implementation Arrangements

The decision point whether what financing scheme to take on may take off from the results of the financial viability analysis of which the direct loan financing scheme (Option 1) is of advantage. Another point, however, would be is whether the proposed investment is viable or not the concession partners like Maynilad are entitled to apply user charges to recover its operating, maintenance and capital expenditures with an agreed rate of rate of return on said expenditures which is termed as the Appropriate Discount Rate (ADR). The agreed ADR for 2003-2007 is 10.4%, for 2008-2012 is 9.3% and the next rate rebasing will cover the 2013-2017 period.

Whichever will be the financing scheme that the Maynilad or MWSI would take, the following are the possible financial and implementation arrangements:

Table 13-13: Possible Financial and Implementation Arrangements

Financing Scheme/Option	**Financial and Implementation Arrangements**	
Option 1 **Two Step Loan thru GFI (either the LBP or DBP)**	Stipulation in the Loan and Project Agreements	Loan Agreement will be concluded between JICA and the GFI and a subsidiary agreement will be concluded between the GFI and the MWSI. A Project Agreement will likewise be concluded between the JICA and the MWSI. The GFI will act as borrower of the loan and will passed on the JICA loan charges plus the GFI's own loan charges (front end fee, exchange rate risks, interest during construction and others) to the Maynilad or MWSI. The charge will likewise include the guarantee fee of 1% of total loan amount as required by the Philippine Government (as the loan guarantor) for all foreign borrowings. Counterpart funds will likewise be provided by the MWSI.
	On Project Management and monitoring	No need to put up a project management unit just for the Project since the GFIs (LBP and DBP) have mainstreamed their project management and monitoring functions. MWSI will (i) prepare the engineering studies and designs and carry out procurement; (ii) construction supervision and management and (iii) prepare the required reports on progress progress, environmental aspects and settlement including public consultations and disclosures. The GFI will be responsible for ensuring the Project will be implemented by the Maynilad (or MWSI) consistent with the Loan and project agreements, including compliance to the loan covenants.
Option 2 **Direct Loan thru the MWSS**	On the Borrower and Executing Agency	Under this Option (as earlier mentioned in this Chapter), the MWSS will be the borrower and the Maynilad or MSI will be the implementing organization. All the applicable loan charges (i.e. interest during construction and commitment charges of the JICA loan facility and the guarantee fee required by the Philippine Government) will be passed on to Maynilad. Initial discussion with MWSS indicates that the MWSS will not charge management fee to Maynilad.

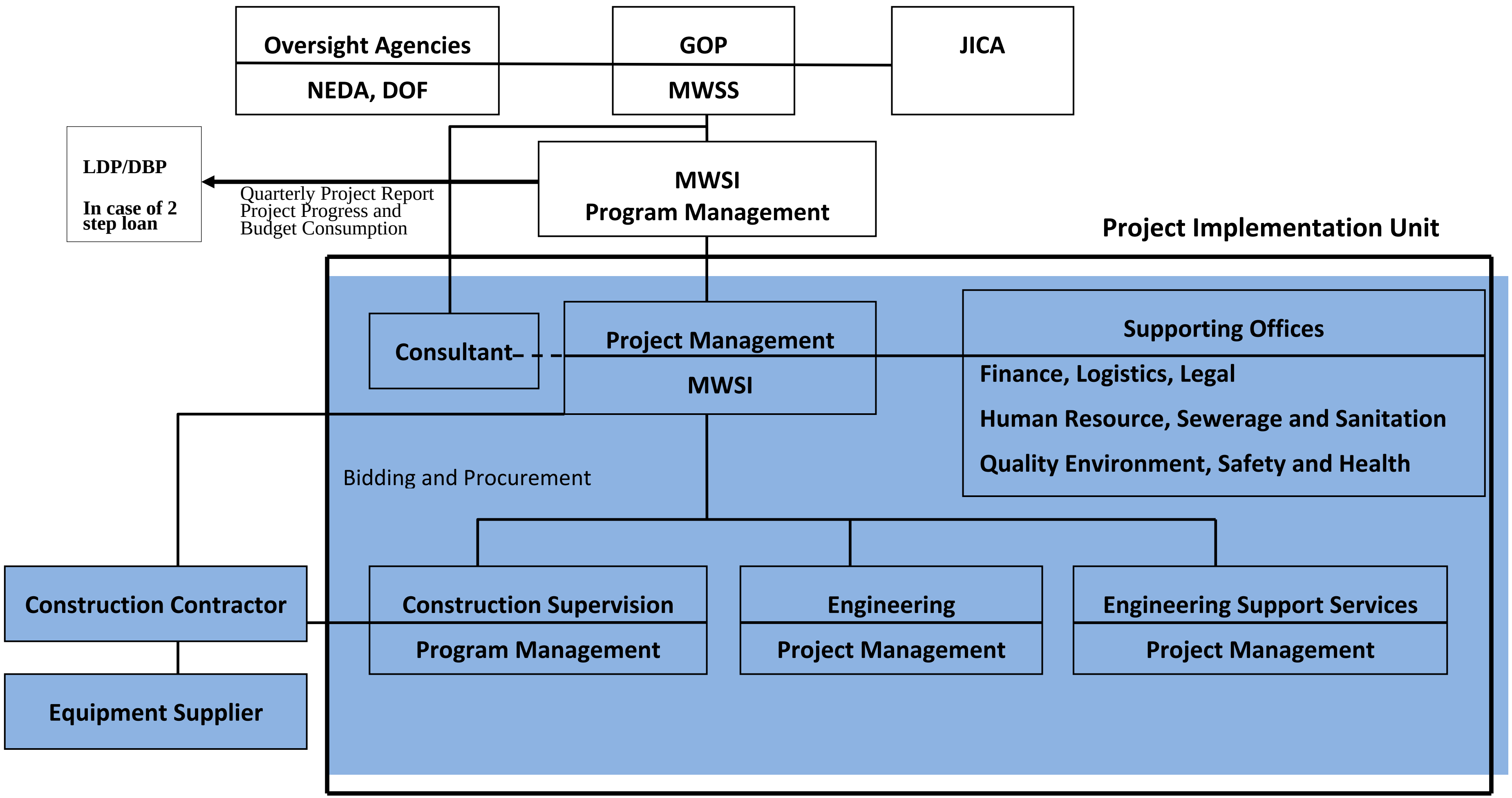
	On the Concession Agreement and Amendments	It should be noted that the computations under the Direct Loan Financing Option (2) are all beyond the concession period. This implies that the possibility of another extension of the Concession Period may be considered by MWSS and Maynilad (and the other concession partner which is the MWCI) to allow for the implementation of the proposed Project. Under this scheme the existing agreements (i.e. service obligations including debt servicing, rate rebasing every five years, concessional fees to MWSS and others---- refer to Section 13.1.2 of this Chapter) between the MWSS and its private partners stand. However, if there may be agreements (e.g. procurement) that need to be amended should be discussed prior to or during appraisal period. Figure 13-5 show the Project Implementation Structure where the Project Implementation Unit staffs will be from the MWSI.

Implementation Arrangement with other Agencies. During the implementation or operation phase of the proposed Project, the Maynilad or MWSI as the executing agency will need to coordinate/collaborate with various concerned government agencies to effectively carry out its mandate. Table 13-14 presents the roles of relative agencies and the implementation agencies as well.

Table 13-14. Roles of Relative Agencies and Implementation Agencies

I. ROLES OF RELATIVE AGENCIES	
Local Government Units (LGUs)	• Assist in the selection of site for treatment facilities and information dissemination in the project area • Review the Project including its alignment, and project implementation schedules with other government projects • Ensure security and order during construction phase • Ensure proper maintenance of drainage system
Department of Public works and Highways (DPWH)	• Ensures proper implementation of Project through resolution sold with correction in the project areas • Ensures and assists in the collection and transport of solid wastes in the project area • Ensures proper maintenance of drainage in collaboration with LGUs and MMDA • Reviews the Project including its alignment, and project implementation schedules with other DPWH projects
Department of Environment and Natural Resource (DENR)	• Ensures that no untreated industrial wastes will enter the drainage system • Assists in the speedy issuance of environmental permits for the Project • Reviews the Project including its alignment, and project implementation schedules with other government projects
Metro Manila Development Authority (MMDA)	• Ensures proper implementation of Project through resolution sold with correction in the project areas • Ensures in the proper maintenance of drainage system and assist in traffic management
Department of Health (DOH)	• Monitors implementation of Project based on the existing Sanitation Code • Assists in the issuance of sanitation permits for the Project
II. ROLES OF IMPLEMENTATION AGENCIES	
Government of the Philippines (GOP)	• Approves Project, provides sovereign guarantee and secures loan from JICA for financing of proposed Project
Manila Waterworks and Sanitation Services (MWSS)	• Monitors Project implementation of MWSI and submits report to JICA • Reviews Project proposal of MWSI and recommends to GOP for government borrowing from JICA and submits NJLA
Maynilad Water Services Incorporated (Maynilad or MWSI)	• Prepares and submits Project proposal to MWSS • Implements the Project and submits report to JICA and provides funds for loan payment

Figure 13-15. Project Implementation Structure under Financing Scheme/ Option 2



B. ECONOMIC VIABILITY ANALYSIS

13.6 Affordability to Pay for the Services

In lieu of the absence of an updated Willingness-to-Pay (TP) for the proposed sanitation and sewerage services particularly for Las Piñas and Parañaque, secondary data from the National Statistics Office (NSO) , National Statistics Coordination Board (NSCB) and other studies conducted by academe and private institutions are used as proxy indicators to initially present the degree of affordability of the target population/residents in the target areas. It is noted that results of this type of survey will determine the "go or no go" of a project because a project without social acceptability is not sustainable.

Past Studies of Income and Expenditures In April 2005, the Willingness to Pay Survey for a Sewerage System (with three project alternatives or options) was conducted to determine the degree of willingness and affordability to pay of residents in the east zone and west zone concession areas where Las Piñas and Parañaque are situated. Based on gathered data, the income and expenditure profile of the 200 survey respondents are presented in the Table 13-15

Table 13-15: Total Income, Total Expense and Net Income (Monthly)

HH Type		Total Income	Total Expenses	Net Income
Blighted/Low Income	No. of Respondents	954	954	931
	Mean	10,007	7,566	2,470
Middle Income	No. of Respondents	568	606	560
	Mean	20,613	13,015	7,690
Upper Income	No. of Respondents	343	386	338
	Mean	51,429	21,054	31,148
Total	**No. of Respondents**	**1865**	**1971**	**1829**
	Mean	**20,855**	**11,883**	**9,368**

Data Source: Sewerage and Sanitation Master Plan for Metro Manila (2005-2025)

The results of the 2005 WTP survey relatively reflected the general economic situation based on the National Statistics and Coordination Board (NSCB) survey. The annual per capita poverty and food thresholds increased from PhP12,309 in 2003 to PhP15,057 in 2006 for the poverty threshold and the food threshold likewise increased from PhP8,149 in 2003 to PhP10,029 in 2006. In terms of poverty incidence, those for the household/family population the incidence has increased from 24.4 percent in 2003 to 26.9 percent in 2006. Likewise, the same trend is posted for the population poverty incidence which reflected a 30 percentage rate in 2003 to 32.9 percentage rate in 2006.

In terms of food threshold and subsistence incidence, 2003 posted an annual per capita food threshold of PhP8,149 and has increased to PhP10,025 in 2006. Subsistence incidence of families/households posted 10.2 percent in 2003 and increased to 11.0 percent in 2006. The same trend is observed for the subsistence incidence of population, from 13.5 percent in 2003 to 14.6 percent in 2006.

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Statistics shown in Table 13-16 indicate that the blighted/low and middle income families enrolled in the WTP survey, conducted in the east and west concession areas of MWSS, are below the per capita income threshold and are therefore belong to the urban poor households.

Table 13-16: Annual Per Capita Poverty and Food Thresholds, 2003-2006 (preliminary estimates as of 03 March 2008)

Indicator	2003	2004	2005	2006
Poverty Threshold and Poverty Incidence				
Annual per capita poverty threshold (in Pesos)	12,309	13,113	14,196	15,057
Poverty Incidence of Families (%)	24.4	--	--	--
Poverty Incidence of Population (%)	300	--	--	--
Food Threshold and Subsistence Incidence				
Annual per Capita Food Threshold (in Pesos)	8,149	8,734	9,350	10,025
Subsistence Incidence of Families (%)	10.2	--	--	--
Subsistence Incidence of Population (%)	13.5	--	--	--

Data Source: NSCB and NSO, 2003-2006

Poverty threshold is the cost of the minimum basic needs (i.e food and non-food) or the minimum income/expenditure required for a family or individual to meet the basic food and non-food requirements. As of 2008, the poverty line of the National Capital Region (NCR) is estimated at Php24,000 per capita per year. In 2009, NSCB reveals that a family of five (5) should have at least a monthly income of Php4,869 to meet food needs and an income of Php7.017 or a daily income of Php231 to stay out of poverty. In Metro Manila, alone, a family of five (5) needs Php8,251 per month to stay out of poverty (NSCB, 2009). The NCR posted as the region with the lowest incidence of poverty (2.6%) relative to other regions in the country. It posted a decreasing trend on poverty incidence from 2.1% in 2003, 3.4 in 2006 and 2.6 in 2009. In summary the four (4) districts of NCR , along with Batanes, Benguet, Cavite, Rizal and Pampanga, were consistently included as least poor cluster of provinces in 2003, 2006 and 2009.

A family income-expenditure survey is conducted every three (3) years by the NSO as an input to the calculation of critical poverty data to monitor the poverty condition in the country. In 2006 the average family income in the NCR was Php221,000 with an expenditure of Php183,000 and the figures increased in 2009 with Php227,000 income with an expenditure of Php197,000. Items included in a family expenditure list are food (42.6%), rental (13.6%), transport and communication (7.4%), fuel light and water (6.5%), education (4%), personal care and effects (3.9%), clothing footwear and others (2.9%) and taxes (2.2%). With an average family annual expenditure of Php 197,000 (or Php16,417 per month), the combined share (2.9% of total family expenditure) of fuel, light and water is valued at Php5,713 per year or 476 per month. This figure on share of the combined fuel, light and water fall short (by Php122.41) from the computed the project impact on tariff (Php0.036 to basic water charge for an average 30 cubic meter family consumption) which results to Php598.41 monthly bill. Thus, there is the need to conduct a WTP survey to ensure that the targeted families will pay for the sewerage and sanitation services from the proposed Project sans the rate rebasing done every five (5) years.

13.7 Corporate Social Responsibility (CSR) of the Maynilad (MWSI)

The CSR is often considered as the business conscience. It reflects how a company, such as the Maynilad, behaves in the conduct of its business and caters to the needs of its various stakeholders in the west zone of the greater Manila area. Maynilad through its CSR department defines CSR as "giving back by paying forward". Project stakeholders particularly the less privileged households will also benefit from the CSR activities of the Maynilad in the near future. Table 13-17 highlights some of the significant CSR projects which would best picture their ways of giving back to the West Zone communities:

Table 13-17: Maynilad's CSR Projects and Activities

CSR Project/Activity	Highlights
Lingkod Eskwela Program	• 46 public schools now enjoy safe and reliable drinking water from the drink-wash areas installed by Maynilad inside their campus, free of charge • Enhances the learning of students through study tours and discussions that develop their hygienic practices and awareness of environmental preservation
Samahang Tubig Maynilad (STM)	• STM is a community development program which provides marginalized communities with access to clean water. • Communities are organized into cooperatives, generally, to work on issues which prevent them from getting the Maynilad connection, such as the right-of-way conflicts, land disputes, limited finances and prevalence of water retailer syndicates. This program also develops the residents' capacities to run their own distribution system. • Maynilad piloted STM in the stretch of waterless households in Tondo, Manila.
Twining Partnerships	• CSR is also about building stronger partnerships for improved service to communities. Maynilad realizes this by sharing its best practices and experiences through various Twinning Programs. • Maynilad has partnerships with local water districts (e.g. Bacolod City Water District, Leyte Metro Water District and San Pedro Water District. In partnership with the United States Agency for International Development-Environmental Cooperation Asia (USAID-ECOASIA), Maynilad has been working with countries such as Indonesia and Malaysia.
Other Activities	• Lingkod Ginhawa (disaster relief programs) • Lingkod Kalikasan (pro-environment initiatives) • Maynilad Volunteer Program which encourages Maynilad employees to participate in various CSR initiatives of the Maynilad (MWSI)

Data Source/s: Ripples (Official Maynilad Newsletter) Vol II, March 2011

13.8 Results of the Economic Cost-Benefit Analysis

13.8.1 Projected Economic Benefits of the Project

The economic benefits of the proposed project are both qualitative and quantitative. Relative to the nature of the Project, a World Bank study in 2008 enumerated the primary economic benefits of sanitation and sewerage, as presented in Table 13-18.

Table 13-18. Economic Benefits of Sanitation and Sewerage

Type of Benefit	Rationale	Measurement	Limitations	Estimated Values
Public Health Benefits	A better sewerage and sanitation system leads to lower morbidity and mortality rates. The prevented health expenditure costs and premature deaths can actually be measured and form part of the economic benefit.	Morbidity cost includes direct costs (medical and hospitalization costs) and indirect costs (loss of income due to reduced workdays).The economic cost of premature death is calculated as the present value of the foregone income stream of the remaining productive life, reckoned from the average age of death and the average life expectancy for Filipinos which is 70 years.	It is difficult to isolate the impact of water supply availability vis-a-vis sewerage and sanitation coverage on a macro scale. How much of the prevented costs can be attributed to the sewerage and sanitation is left to the best judgment of the analyst.	Based on a recent World Bank study*, annual health cost attributed to poor sanitation is Php286 per head. *The estimate is accounted for largely by the economic cost of premature deaths.* Direct financial costs amount to Php24 per capita per year.
Drinking Water Access Costs	Improper disposal of domestic water into bodies of water affect the access of clean water. Water consumers and providers spend on treatment costs because available water is not clean.	The benefit is measured by the estimated cost of household treatment and purchased piped and non-piped water.	Again, it is very difficult to find an estimate of the benefit given that the sewerage project is local while the water systems have trans-boundary characteristics.	In the National Capital Region, annual drinking water costs amount to PhpP1.92 billion (US$34.8 million) or Php175 per capita according to WB*.
Commercial Benefits -Tourism Impacts	Better sanitation and sewerage facilities attract more tourists.	This benefit is measured by the increase in the average days of stay times the average spending per tourist.	The impact on tourism is difficult to quantify because of many uncontrolled variables which affect the tourism industry. A lot of studies need to be done to establish the link.	WB estimates* the amount of lost tourism receipts due to poor sanitation to be at US$40.1 million (Php26 per capita) per annum.

Data Source: *Economic Impacts of Sanitation in the Philippines, Water and Sanitation Program – East Asia and the Pacific, World Bank 2008.*

For purposes of quantifying the benefits of the proposed Project the following health-related benefits were used in the viability computations: (1) avoided cost of medical expense due to water-related disease; (ii) savings due to reduced morbidity cases and (iii) savings due to reduced mortality cases.

Table 13-19 show the following assumptions used in the cost-benefit computations:

Table 13-19: Assumptions Used in the Economic Viability Computations

Period of Analysis	50 years period of analysis was used in the computations which was based on Financing Option 2 or the Direct Loan Scheme Standard preferential term which involved 10 years grace period and 40 years repayment
Conversion of Financial Cost of Capital Investment and Operating and Maintenance to Economic Costs	<u>Computation for the Investment Economic Cost:</u> Assumed the 60:40 material to labor proportion both for the investment cost. For the materials component, 30% is assumed as imported component while 70% is local. The imported component is subjected to a shadow exchange rate of 1.2. For the labor component, 60% is assumed as unskilled labor while the 40% is unskilled. The unskilled portion is subjected to a shadow wage rate of 0.6. <u>Computation for the OM Economic Cost:</u> Assumed the 40:60 material to labor proportion both for the OM cost. For the materials component, 40% is assumed as imported component while 60% is local. The imported component is subjected to a shadow exchange rate of 1.2. For the labor component, 60% is assumed as unskilled labor while the 40% is unskilled. The unskilled portion is subjected to a shadow wage rate of 0.6.
Economic and Health Indicators for the Computation of Economic Benefits	• Morbidity rate of 2% • Mortality rate of 2% • Labor Force Participation of 66.7% • No. of Days Affected in a Year = 2 • Ave. Medical Expense per Infection = Php 1000 • Wage Rate (Daily and Monthly for NCR) • Served Population per Phase
Economic Benefits Identified	• **Avoided Cost of Medical Expense due to Water-related Disease** (1) = Served Population x Morbidity Rate X Medical Expense x 60% • **Savings due to Reduction in Moridity** (2) = Served Population x Morbidity Rate x LFPR x

	Daily Wage Rate xMedical ExpensexDays Inactivex 60% • **Savings due to Reduction in Mortality** (3) = Served Population x Mortality Rate x LFPR x Annual Wage Rate x 60%

The results of the computation yielded economically viable figures on the recommended least cost technical design for the Las Piñas and Parañaque Sewerage and Sanitation Project, as shown in Table 13-20. The NEDA recommended 15% discount rate was the hurdle rate used to determine the economic viability of the respective phases and overall Project. Please refer to Annexes 13.M.1-5 for the detailed computations.

Table 13-20: Results of the Financial Viability Computations

	Viability Indicators	
	Economic IRR	**NPV @15% Discount Rate in Php Billion**
Phase 1	31%	7.634
Phase 2	31%	6.781
Phase 3	26%	6.038
Phase 4	22%	1.547
Overall Project	**31%**	**13.806**

C CONCLUSION AND RECOMMENDATIONS

Investing on sanitation and sewerage projects is not generally financially-attractive. But the fact that it is a basic service, it will significantly impact on the socio-economic conditions of the target populace in terms of health (i.e. access to potable drinking water, reduction in morbidity and mortality cases) and economic activities like tourism and commercial businesses.

The total investment (base cost estimates) to avail of sewerage and sanitation services from the proposed Project is Php 24.775 billion which can be translated into a per capita investment of Php18,259 relative to the target population of 1,356,866 or an investment Php127,814 per household.

More so, as discussed in the affordability of the target households in paying for additional charges which accrue to the sewerage and sanitation services by the proposed Project, the need to determine the degree of willingness to pay should be determined either prior to Project construction or commencement of service through the conduct of a WTP survey. Conducting the WTP for the target households of the proposed sanitation and sewerage project is critical to cash planning of the MWSI because this primarily determines the projected revenues of the proposed project.

Another critical issue relative to the recommended Direct Loan Financing Scheme is the borrowing ceiling of the MWSS if its role is to act as borrower of the ODA loan which comprised 81% of the total Project investment. This should be thoroughly discussed by the MWSS and Maynilad (or MWSI) on the specific steps to address the situation. Relatedly, the financial borrowing ceiling of the Philippine Government also is critical to the availment of the proposed loan. This should be addressed by the concerned agencies like the NEDA, the DOF , the MWSS and the MWSI as well.

Also seen as a critical element in the implementation of the proposed Project is capacity of the MWSI to provide for the needed lands that would be used. Although it is worth noting that the MWSI has already made initial consultations with private land owners of the affected lands but no procurement has been made yet. They, however, stressed that they are committed to provide for the needed land area relative to their business plan targets.

Given the results of the financial and economic computations relative to the financing schemes being considered in this Assessment, the Table below summarizes the strengths and weaknesses of the respective schemes:

Table 13-21. Pros and Cons of the Financing Options

	Financing Scheme 1 (Two Step Loan)	**Financing Scheme 2 (Direct Loan)**
Financial Feasibility based on ADR 9.3%	• LBP exhibits non-feasibility if tariff would only come from environmental charges. This is consistent among the four development phases and overall project computations. [-] • DBP only exhibits financial feasibility in Phase 2 but the rest and overall project computations are not feasible. This is true to scenario where tariff would only come from the environmental charges[-] • LBP and DBP exhibit high feasibility if tariff would come from environmental and sewer charges [+]	• All Options under the JICA Loan facility conditions for Low-Middle Income Countries show that Phase 4 is not feasible if treated individually but overall project computations generally exhibit feasibility This is true to the scenario where the tariff would only come from environmental charges [+] • All Options under the JICA Loan Facility exhibit high feasibility if tariff would come from both environmental and sewer charges [+] • Among the four (4) Options under the JICA Loan Facility for Low-Middle Income Countries, computations using the Standard Preferential Term (1.75% interest, 40 years repayment and 10 years grace period) relatively exhibits positive financial feasibility indicators [+]
Economic Feasibility based on NEDA recommended 15% discount rate	• Both LBP and DBP exhibit high economic feasibility indicators [+]	• All Options under the Loan Facility exhibit high economic feasibility indicators [+]
Exposure to ODA Borrowings	• LBP foreign borrowings amounted to Php30,156.5 million as of December 2009. National Government has provided foreign exchange risk cover (FXRC) on the Php23,530.34 million which has a historical value of Php18,770.72 million. LBPs foreign borrowings from multilateral and bilateral agencies have maturities ranging from 15 to 40 years. [+]	• Borrowing Ceiling is Php3 billion or USD 600 million; Available balance amounts to Php76 million or USD408 million. Note that there still are relevant financial information that the MWSS has yet to disclose [+] as of FS report preparation. • If MWSI opts for Direct Loan, the possibility that MWSS can still accommodate said loan within their ceiling will depend on the disclosure of relevant financial indicators from

	Financing Scheme 1 (Two Step Loan)	Financing Scheme 2 (Direct Loan)
	• MWSI Project recently approved loan from the World Bank with LBP as borrower may be hindrance for a second foreign borrowing for a MWSI project since the Philippine Government has limited foreign borrowing ceiling and the government sector is a priority of said ceiling [+] • Based on 31 December 2010 Balance Sheet, the DBP has Total Assets valued at Php 297.295 billion with Total Liabilities and Stockholders' Equity worth Php256.920 billion and Php40.374 billion, respectively. Under the Liabilities, bills payable for ODA (overseas development assistance) amounted to Php39.589 billion. Higher foreign borrowing exposure compared to LBP [-]	MWSS [+ and -]
Implication to Existing Concession Period	• Payment period will go beyond present Concession Period in case of selection of the longest repayment period applicable.	• Payment period will go beyond present Concession Period in case of selection of the longest repayment period applicable.
Absorptive Capacity of Borrower and Executing Organization	• Both LBP and DBP have vast experience on financing ODA-funded projects [+] • MWSI have already partnered with the DBP with earlier projects and recently with the LBP	• Existing concession arrangements help may in the implementation and management of the proposed Project [+]
Smoothness of Management Decision	• MWSI's previous and present partnership with both GFIs may help in the implementation and management of proposed Project [+]	• Existing concession arrangements help may in the implementation and management of the proposed Project [+]

Note: If it is positive a [+] sign is seen after the phrase or statement, while the a [-] if otherwise.

Based on the above Assessment, the *Direct Loan Scheme using the Standard Preferential Term* for Lower-*Middle Income Countries* like the Philippines is the most advantageous among other options within the Direct Loan Scheme and the Two Step Loan Scheme through the GFIs like the LandBank and DBP. Financial and economic computations for the said Scheme indicated Project viability based on the financial hurdle rate of 9.3% appropriate discount rate adopted by the Concession partners for determination of financial viability and economic hurdle rate of 15% discount rate recommended by the NEDA for economic viability assessment (refer to Tables 13-11 and 13-16 for the results of the financial and economic viability assessments, respectively) . However, since the said Financing Scheme entails payment period way beyond the target closure of the Concession Period in 2037, the possibility of another extension can be considered by the Concession Partners with respect to the MWSS and the MWCI.

Lastly, if the Direct Loan Scheme (using the Standard Preferential Term) would be considered by the Maynilad in availing the loan from the JICA ODA loan facility all possible financing and implementation arrangements (aside from the existing ones being practiced in the existing Concession Period) should be discussed by both MWSS and Maynilad to avoid possible conflicts during the implementation phase of the proposed Project.

14 ENVIRONMENTAL ASSESSMENT

This sewerage project is an environmental enhancement and mitigation project which will primarily improve the quality of the receiving bodies of water bordering the catchment areas of Parañaque and Las Piñas towards Manila Bay. However, the project alone cannot impact significant improvement to Manila Bay unless wastewater collection and treatment systems in the adjacent sub-catchment areas discharging to the bay are to be improved as well.

During the construction period, there will be minimal and localized disturbance such as traffic, dust emission and noise in the surrounding areas primarily brought about by excavation and pipe laying works. Appropriate mitigating measures can be easily implemented to minimize any nuisance to the community. During operation, particularly in the treatment plant, problems on noise and odor may arise but may be mitigated by proper operation and maintenance procedures.

14.1 Proposed Environmental Improvement

The Project shall comprise of three (3) main components: 1) sewerage treatment plant (STP); 2) pumping stations (PS); and sewer lines. The STP is the primary facility that will treat the sewage prior to disposal. The pumping stations will be constructed in strategic locations to convey the sewage from the various networks towards the STP. The sewer lines (combined sewerage system) shall provide the necessary conduit for the raw sewage (combined flow during wet season).

In the initial project feasibility study, there were eight (8) options developed. Out of these options, MWSI will select the scheme that will be the most economical and technical viable, while having manageable impact on the surrounding environment during project construction.

In brief, **Table 14-1** presents the description of the different options for the Project.

Table 14-1: Description of Project Options

Project Option	Description
Option 1	All areas of Paranaque and Las Pinas will be treated as a single treatment district (1 treatment plant). The treatment plant is located in the middle of the design area, where it is easy to collect sewage and a large area of land can be secured for the STP.
Option 2	Paranaque and Las Pinas will be respectively treated a single treatment district (2 treatment plants). The plants are to be located by MWSI.
Option 3	Six treatment districts, i.e. one for each drainage system (4 treatment plants in Paranaque and 2 in Las Pinas), will be proposed. The plants are located in the areas to be designated by MWSI. Location of a treatment plant in the reclaimed area of Paranaque is presumed.
Option 4	The treatment districts of Option 3 are simplified into five districts (3 treatment plants in Paranaque and 2 in Las Pinas). The plants are located in areas designated by MWSI. It is assumed that the reclaimed area of Paranaque has one treatment plant site.
Option 5	The treatment districts of Option 4 are divided into seven districts (5 treatment plants in Paranaque and 2 in Las Pinas). The plants are to be located in areas designated by MWSI.
Option 6	Similar to Option 4 but with different location sites of STPs and treatment districts
Option 7	Similar to Option 4 but with different location sites of STPs and treatment districts
Option 8	Similar to Option 5 but with different location sites of STPs and treatment districts

14.2 Project Setting

14.2.1 Needs Analysis

MWSI intends to improve the wastewater coverage within its concession area from 11% in 2011 to 66% in 2021 and ultimately 100% sewerage connection by 2036 (MWSI Business Plan, 2008). Several master plans were developed and have defined the road map towards these sewerage targets. The acceleration of sewerage projects of MWSI is compliance to the Supreme Court order to MWSS to adequately treat wastewater being discharged to Manila Bay at the earliest possible period.

14.2.2 Goals and Objectives

This project is proposed to establish sewerage treatment and management systems in the project target areas, Parañaque and Las Piñas, for the purpose of improvement of sewerage and sanitation environmental conditions by improvement of surface water quality of Paranaque River and its tributaries, which would reduce water borne diseases and the much higher morbidity rate in the areas down to the level of water quality in Manila or Makati Cities where sewerage services have been already put in service, of which water born disease rate per 100,000 is as small as one tenth the project areas, and eventually devoting to improvement of the life and health status of urban residents in the areas (refer Table 8.3.8).

The overall goal of the proposed Project is to provide a safe environmental setting for the long-term growth of Metro Manila through the following:

- Economic and industrial growth in Metro Manila; and
- Improvement of public health and hygienic situation in the urban environment.

Within this framework, the specific objectives of the proposed Project are to:

- Enhanced wastewater, city/municipal solid waste management, human waste and storm water management;
- Reduced pollution through the facilitation of pollution controls;
- Expanded wastewater treatment and water quality monitoring;
- Improved the city/municipal wastewater utility financial management; and
- Supported training, feasibility studies, and future investment for the sewerage and sanitation improvement project in the study area.

The logical parameters to monitor the project effectiveness shall be as follows;

Surface Water Qualities: Parañaque River, Kay Boboy Creek, Don Galo River, San Dionisio River are main waterways discharging into Parañaque Channel into Manila Bay.

The current surface water quality of those rivers, creeks and tributaries is from 16 to 39mg/l on BOD_5 base. And Las Piñas River and Zapote River are main waterways discharging into Manila Bay. Surface water quality of the rivers and their tributaries is from 13 to 46 mg/l on BOD_5 base. (Refer **Table 7-8**). The water quality of the waterways will be improved less than 7 mg/l_BOD_5 of DENR Standard, when completion of the project

Economical Effects: The parameters to monitor the economical effect by the project shall be:(refer Section 8, **Table 8-3-13**)

Served Population: 427,932 of Phase 1 and final (Phase 4) 1,356,886

Medical Expenses per Infection: 1,000P (current) down to 500P

Daily wage rate: 385.5P up to 770P

Labor force participation rate: 66.7% up to 70%

Morbidity: 2.0% down to1.0%

14.2.3 Project Impact Area

The environmental assessment covers the cities of Paranãque and Las Pinãs. Most of the information that were included in this document were based on the secondary sources, such as reports from the Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB), profile of the host cities, and previous feasibility studies conducted. A comprehensive environmental and social scoping report describing the detailed baseline environmental data of the study areas is presented in **Annex 4** of this Report.

14.3 Significant Environmental Baseline Information

14.3.1 Geology

The underlying geology of Parañaque and Las Piñas is classified to belong within the Guadalupe Plateau. This soil formation comprise of resistant volcanic rocks, which makes it generally less susceptible to flooding and seismic movement, and provides greater soil stability. There are also no nearby active fault lines or volcanoes. This geological characteristic is favorable for establishing all types of buildings and structures.

Table 14-2 summarizes the general soil characteristics in Metro Manila. The soil in Parañaque is classified under Guadalupe Soil. It is volcanic eject that produces a loam to clay loam texture that can hold more water. The soil contains more clay than silt. Its permeability is low with high swelling capacity. Furthermore, alluvial plain in Las Piñas is composed of sand and clay with shell fragments (JICA Study on Metro Manila Groundwater Development). The alluvium is observed to extend to depths of about 10 to 20 meters. The hilly portion is composed of sandstone, conglomerate, mudstone and stuff, and reaches a thickness of 2,000 meters.

Table 14-2: General Soil Characteristics in Metro Manila

Parameter	Physiographic Zones				
	Coastal Margin	Reclamation	Guadalupe Plateau	Marikina Valley	Laguna Lowlands
Slope	Less than 1%	Less than 1%	0-12%	Less than 1%	Less than 1%
Flooding Frequency	High	Low	None to Very High	High to Very High	High to Very High
Soil Drainage	Poor	Moderate	Good	Very Poor	Poor

Depth to Water Table	Very Shallow	Shallow	Deep	Extremely Shallow	Very Shallow
Depth to Bedrock	Very Deep	Very Deep	Shallow	Very Deep	Very Deep
Soil Stability	Low	Very Low	Moderate to High	Very Low	Low
Soil Corrosivity	High	High	Very Low	High	High
Earthquake Damage Risk	High	Very High	Low	Very High	High

Source: Mines and Geosciences Bureau

14.3.2 Land Use

The total land areas of the cities of Parañaque and Las Piñas are dominated with residential areas, followed by commercial then industrial, as shown in **Table 14-3**.

Table 14-3: Land Use Profile of Parañaque and Las Piñas

Land Use Classification	Area			
	Parañaque		Las Piñas	
	Area (km^2)	%	Area (km^2)	%
Residential	22.82	49	22.68	71
Commercial	14.04	30	6.41	20
Industrial	5.33	12	1.42	4
Institutional	0.60	1	0.68	2
Open spaces, roads, parks	3.78	8	0.80	3
Total	**46.57**	**100**	**31.99**	**100**

Source: Mega Manila Public Transportation Study, JICA April 2007, latest available data as of March 2010.

Since there is no final area yet chosen for the STP, **Table 14-4** lists the land use classification of the different candidate STP locations per project option.

Table 14-4: Classification of Land Use of the Proposed Project's Facilities

Project Option	Location		Land Use	Remarks[1]
	ID No.	Address		
Option 1				
STP No. 1	L-C+L-10	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Utility	MOA
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 5	PS-5	Golden Haven Memorial Park, Las Piñas City	Cemetery	MOA
PS No. 6	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated

Project Option	Location		Land Use	Remarks[1]
	ID No.	Address		
PS No. 7	PS-7	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Residential	Possible ROW issue
PS No. 8	PS-8	Matthew St. cor. Mark St., Parañaque City	Residential	Possible ROW issue
Option 2				
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	Industrial	To be negotiated
STP No. 2	L-C+L-10	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Utility	MOA
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 5	PS-5	Golden Haven Memorial Park, Las Piñas City	Cemetery	MOA
PS No. 6	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated
PS No. 7	PS-7	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Residential	Possible ROW issue
PS No. 8	PS-8	Matthew St. cor. Mark St., Parañaque City	Residential	Possible ROW issue
Option 3				
STP No. 1	P-1	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Residential	Possible ROW issue
STP No. 2	P-6	Lincoln Ave., Parañaque City	Commercial	To be negotiated
STP No. 3	P-3	C-5 Road Extension (near SM Warehouse), Parañaque City	Industrial	To be negotiated
STP No. 4	P-12	Matthew St. cor. Mark St., Parañaque City	Residential	Possible ROW issue
STP No. 5	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Industrial	To be negotiated
STP No. 6	L-C	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Utility	MOA
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated
Option 4				
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	Industrial	To be negotiated
STP No. 2	P-1	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Residential	Possible ROW issue
STP No. 3	P-6	Lincoln Ave., Parañaque City	Commercial	To be negotiated
STP No. 4	L-A	Alabang-Zapote Road (near RSTI Compound), Las	Industrial	To be negotiated

Project Option	Location		Land Use	Remarks[1]
	ID No.	Address		
		Piñas City		
STP No. 5	L-C	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Utility	MOA
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated
Option 5				
STP No. 1	L-22	Tropical Ave. (near former Tropical Palace), Parañaque City	Residential	Possible ROW issue
STP No. 2	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	Industrial	To be negotiated
STP No. 3	P-4	Moonwalk Access Road, Parañaque City	Residential	Possible ROW issue
STP No. 4	P-1	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Residential	Possible ROW issue
STP No. 5	P-6	Lincoln Ave., Parañaque City	Commercial	To be negotiated
STP No. 6	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Industrial	To be negotiated
STP No. 7	L-C	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 2	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 4	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated
Option 6				
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	Industrial	To be negotiated
STP No. 2	P-4	Moonwalk Access Road, Parañaque City	Residential	Possible ROW issue
STP No. 3	P-6	Lincoln Ave., Parañaque City	Commercial	To be negotiated
STP No. 4	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Industrial	To be negotiated
STP No. 5	L-C	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Utility	MOA
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated
Option 7				

Project Option	Location		Land Use	Remarks[1]
	ID No.	Address		
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	Industrial	To be negotiated
STP No. 2	P-2	NAIA Road, Parañaque City	Residential	Possible ROW issue
STP No. 3	P-6	Lincoln Ave., Parañaque City	Commercial	To be negotiated
STP No. 4	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Industrial	To be negotiated
STP No. 5	L-C	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Utility	MOA
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated
Option 8				
STP No. 1	L-22	Tropical Ave. (near former Tropical Palace), Parañaque City	Residential	Possible ROW issue
STP No. 2	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	Industrial	To be negotiated
STP No. 3	P-4	Moonwalk Access Road, Parañaque City	Residential	Possible ROW issue
STP No. 4	P-2	NAIA Road, Parañaque City	Residential	Possible ROW issue
STP No. 5	P-6	Lincoln Ave., Parañaque City	Commercial	To be negotiated
STP No. 6	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Industrial	To be negotiated
STP No. 7	L-C	S. Marquez St., Las Piñas City	Commercial	To be negotiated
PS No. 1	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Residential	Possible ROW issue
PS No. 2	PS-3	Opal St., Las Piñas City	Residential	Possible ROW issue
PS No. 3	PS-4	J. Aguilar Ave., Las Piñas City	Industrial	To be negotiated
PS No. 4	PS-6	Marcos Alvarez Ave., Las Piñas City	Industrial	To be negotiated

Note:
[1]MOA – Memorandum of Agreement between the Proponent and the local government unit (LGU)

Residential zones are considered to be the most sensitive areas for STPs. From **Table 14-4**, Options 4, 6, and 7 has the least number of residential zones that could be affected by the proposed Project, with three (3) sites identified. Meanwhile, the most number of residential zones that could be affected are Options 5 and 8 with each zone listing five (5) sites classified as ‘residential’.

14.3.3 Air Quality

The project area has one air quality monitoring station located in Barangay Pamplona in Las Piñas City. The latest available air quality data from EMB were taken from 2000-2003 where the average total suspended particulates (TSP) was 65.5 µg/Ncm, still below the annual average of 90 µg/Ncm.

There has been no significant change in the TSP concentration in the city since the closing of major industrial businesses in the area. According to the DENR, the highest concentration of TSP is only along major thoroughfares like the Alabang-Zapote Road. The TSP level in residential areas is low.

Table 14-5: Average TSP Concentration in the Atmosphere of Las Piñas City, 2000-2003

Year	Total Suspended Particulates (TSP) Concentration in the Ambient Air (in µg/Ncm)
2000	80
2001	67
2002	78
2003	37

Note: Annual/long term ug/Ncm average is 90 ug/Ncm
Source: DENR-Environmental Management Bureau (NCR), 2007

The main contributors of noise in the project areas are the public and private vehicles plying along the main avenues and city streets. This noise is at its maximum level during peak hours. Another source of significant noise is the landing and take-off of various aircrafts from the Ninoy Aquino International Airport (NAIA) in Parañaque City.

The ambient air and noise quality in Parañaque and Las Piñas will not be negatively affected on the long-term basis, since STP operations do not include processes that emit toxic air pollutants. However, during the construction of the STPs and pipe-laying activities, dust and noise are expected to be generated, but only within the immediate vicinities and only for a short-term basis.

14.3.4 Hydrology

The nearest bodies of water that could be affected by the proposed Project's activities are detailed in **Table 14-6**.

Table 14-6: Water Bodies near the Proposed Project's Facilities

Project Option	Location		Nearest Affected Water Body
	ID No.	Location	
Option 1			
STP No. 1	L-C+L-10	S. Marquez St., Las Piñas City	Las Piñas River
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Don Galo River
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 3	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 5	PS-5	Golden Haven Memorial Park, Las Piñas City	Las Piñas River
PS No. 6	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek

Project Option	Location		Nearest Affected Water Body
	ID No.	Location	
PS No. 7	PS-7	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Parañaque River
PS No. 8	PS-8	Matthew St. cor. Mark St., Parañaque City	San Dionisio River
Option 2			
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	San Dionisio River
STP No. 2	L-C+L-10	S. Marquez St., Las Piñas City	Las Piñas River
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Don Galo River
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 3	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 5	PS-5	Golden Haven Memorial Park, Las Piñas City	Las Piñas River
PS No. 6	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek
PS No. 7	PS-7	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Parañaque River
PS No. 8	PS-8	Matthew St. cor. Mark St., Parañaque City	San Dionisio River
Option 3			
STP No. 1	P-1	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Parañaque River
STP No. 2	P-6	Lincoln Ave., Parañaque City	Manila Bay
STP No. 3	P-3	C-5 Road Extension (near SM Warehouse), Parañaque City	San Dionisio River, Kayboboy Creek
STP No. 4	P-12	Matthew St. cor. Mark St., Parañaque City	San Dionisio River
STP No. 5	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Zapote River
STP No. 6	L-C	S. Marquez St., Las Piñas City	Las Piñas River
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Don Galo River
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 3	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek
Option 4			
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	San Dionisio River
STP No. 2	P-1	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Parañaque River
STP No. 3	P-6	Lincoln Ave., Parañaque City	Manila Bay
STP No. 4	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Zapote River
STP No. 5	L-C	S. Marquez St., Las Piñas City	Las Piñas River
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Don Galo River

Project Option	Location		Nearest Affected Water Body
	ID No.	Location	
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 3	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek
Option 5			
STP No. 1	L-22	Tropical Ave. (near former Tropical Palace), Parañaque City	Almanza Creek
STP No. 2	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	San Dionisio River
STP No. 3	P-4	Moonwalk Access Road, Parañaque City	Libho Creek
STP No. 4	P-1	J. P. Rizal St. (near Don Galo/Sto. Niño Bridge), Parañaque City	Parañaque River
STP No. 5	P-6	Lincoln Ave., Parañaque City	Manila Bay
STP No. 6	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Zapote River
STP No. 7	L-C	S. Marquez St., Las Piñas City	Las Piñas River
PS No. 1	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 2	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 3	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 4	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek
Option 6			
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	San Dionisio River
STP No. 2	P-4	Moonwalk Access Road, Parañaque City	Libho Creek
STP No. 3	P-6	Lincoln Ave., Parañaque City	Manila Bay
STP No. 4	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Zapote River
STP No. 5	L-C	S. Marquez St., Las Piñas City	Las Piñas River
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Don Galo River
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 3	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek
Option 7			
STP No. 1	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	San Dionisio River
STP No. 2	P-2	NAIA Road, Parañaque City	Ibayo Creek
STP No. 3	P-6	Lincoln Ave., Parañaque City	Manila Bay
STP No. 4	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Zapote River
STP No. 5	L-C	S. Marquez St., Las Piñas City	Las Piñas River

Project Option	Location		Nearest Affected Water Body
	ID No.	Location	
PS No. 1	PS-1	Multinational Ave. cor. C-5 Road Extension, Parañaque City	Don Galo River
PS No. 2	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 3	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 4	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 5	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek
Option 8			
STP No. 1	L-22	Tropical Ave. (near former Tropical Palace), Parañaque City	Almanza Creek
STP No. 2	P-11	C-5 Road Extension (near SM Warehouse), Parañaque City	San Dionisio River
STP No. 3	P-4	Moonwalk Access Road, Parañaque City	Libho Creek
STP No. 4	P-2	NAIA Road, Parañaque City	Ibayo Creek
STP No. 5	P-6	Lincoln Ave., Parañaque City	Manila Bay
STP No. 6	L-A	Alabang-Zapote Road (near RSTI Compound), Las Piñas City	Zapote River
STP No. 7	L-C	S. Marquez St., Las Piñas City	Las Piñas River
PS No. 1	PS-2	Pedro Sabido St. cor. R. Garcia St., Las Piñas City	Zapote River
PS No. 2	PS-3	Opal St., Las Piñas City	Zapote River
PS No. 3	PS-4	J. Aguilar Ave., Las Piñas City	Creek near J. Aguilar Ave. and Casimiro Dr.
PS No. 4	PS-6	Marcos Alvarez Ave., Las Piñas City	Talon Creek

Based on the list in **Table 14-6**, Options 1 and 2 may affect seven (7) bodies of water; Options 3, 4, 6, and 7 may affect eight (8) bodies of water; and Options 5 and 8 may affect nine (9) bodies of water. However, all the identified bodies of water drain eventually to Manila Bay. Thus, any impact on the various creeks and rivers will also have effects on the condition of the water in Manila Bay.

14.3.5 Water Quality

Water bodies near the proposed Project's facilities are already considered to be 'highly polluted' due to years of uncontrolled solid and liquid waste dumping, urban run-off, and lack of adequate infrastructure to manage sewage treatment.

Rivers and creeks – DENR reported the degradation of the rivers in Metro Manila characterized by insufficient dissolved oxygen (DO) content and high biological oxygen demand (BOD). At present, there are 7 sampling stations along the Parañaque-Zapote River System. The DENR is closely monitoring the water quality of the Parañaque River for color, temperature, turbidity, potential of hydrogen (pH), DO, BOD, and suspended solids.

Based on the DENR's assessment for 2006, the Parañaque-Zapote River has the lowest DO and has the highest BOD among the monitored river systems in Metro Manila. The average DO is between 1.9 and 2.14 mg/liter; the average BOD is from 14.4 to 41.02 mg/liter and the suspended solids ranges from 2.75 to 12.62 mg/liter. The results of the monitoring, as shown in **Table 14-7**, indicate the poor water quality of the Parañaque-Zapote River.

Table 14-7: Water Quality of the Parañaque-Zapote River, 2006

Parameters	Value	DENR Standard	Assessment	Rating
DO,mg/L	1.19-2.14	5	Failed	Poor
BOD,mg/L	14-41	10	Failed	Poor
pH	7.89	6.5-8.5	Passed	Good

Source: DENR-Environmental Management Bureau (NCR) as cited in Las Piñas City Profile

Water Quality of Manila Bay – Manila Bay is a semi-enclosed estuary located southwest section of Luzon facing the South China Sea. The 60 kilometer long bay has a coastline of approximately 190 km and a surface area of about 1,800 km^2. Its width varies from 22 km to 60 km. It is bounded within the coordinates 120°28´ to 121°15´ east longitude, and between 14°16´ to 15° north latitude. Its 18-km access channel, where Corregidor Island is situated, is about 15 km from the 200-meter contour of the continental shelf. It consists of a gently sloping basin with the depth increasing at a rate of 1 meter per kilometer from the interior to the access channel and has an average depth of 17 meters (PRRP, 1999).

The bay is bordered by coastal cities and municipalities of the National Capital Region or NCR (Manila, Pasay, Parañaque, Las Piñas, and Navotas), and the coastal provinces of Bataan, Pampanga, Bulacan in Region 3, and Cavite in Region 4. The Manila Bay watershed area includes the non-coastal cities and municipalities of the NCR (Quezon City, Caloocan City, Makati, Pasig, Marikina, Mandaluyong, Muntinlupa, Valenzuela, Malabon, San Juan, Pateros, and Taguig), provinces of Nueva Ecija and Tarlac in Region 3, and Rizal and Laguna in Region 4. The entire watershed is approximated at 17,000 km^2 consisting of 23 catchment areas.

Domestic effluent is the main contributor to organic pollution in the Bay. A mere 18% of the domestic wastewater is treated in localized sewerage systems. The rest of the generated domestic wastewater in areas around the bay is directly discharged into it.

Agro-industrial wastewater is accounted as the second largest polluter of Manila Bay. The sources include agricultural runoff and wastewater discharges from poultry and piggeries particularly from the provinces of Tarlac, Pampanga and Bulacan. Major sources of agricultural runoffs include: organic wastes such as decayed plants, livestock manure, and dead animals; soil loss in the form of suspended solids; and pesticides and fertilizer residues. The absence of facilities to intercept surface runoffs from agricultural farms affects the water quality of surface and coastal water.

Industrial wastewater is mostly generated by water intensive industries such as food and dairy manufacturing; pulp and paper products; textile products, and others. Other types of waste include thermal waste, created by cooling processes used by industry and thermal power stations. Both treated and partially treated effluents are often discharged to river systems which eventually received by the bay.

14.3.6 Flora and Fauna

The proposed facilities will be situated in highly-urbanized areas that are classified as residential, commercial, or industrial. These developed areas had already affected negatively the flora and fauna.

Both Las Piñas and Parañaque are built-up and densely populated urban metropolis. Vegetation within idle lands is usually covered with cogon grass. Several unoccupied areas are usually planted with wild bamboos, banana trees, coconut trees, fire trees and other similar wild trees that relatively thrive in Luzon. There are some areas that were planted by the LGUs with trees, shrubs and ornamental plants such as palm trees, pine trees and bushes as part of urban landscaping.

There are no rare or endangered flora and fauna species found and/or identified to be present in the sites of the proposed Project. The plant and animal species that were found were common and growing in abundance in other ecosystems all over the Philippines.

14.3.7 Cultural Heritage

There are no important cultural/historical landmarks on the proposed sites of the project's facilities. The candidate areas identified for the proposed Project's facilities are vacant and undeveloped lots.

14.3.8 Indigenous People

There are no indigenous people/communities identified within the proposed project areas in Parañaque and Las Piñas.

14.3.9 Informal Settlers

The areas of Parañaque and Las Piñas are also host to informal settlers, which are scattered as mini-communities within the different barangays. Some of these informal settlers live along the river/creek banks, while some dwell in vacant lots.

For Parañaque City, the barangays that have a high number of informal settlers are Barangays San Isidro, San Antonio, B.F. Homes, San Dionisio, Sto. Niño, and Tambo. Meanwhile for Las Piñas City, the barangays that have a high number of informal settlers are CAA Compound, Zapote, Pamplona, Manuyo, Almanza, and Talon. The exact locations of informal settler communities in Parañaque and Las Piñas are shown in **Annex 4**.

14.4 Project Implementation

14.4.1 Pre-construction Phase

The pre-construction phase comprises of different tasks prior to any construction, development, or operation of the proposed Project. These preliminary tasks are necessary to ensure the compliance and proper implementation of the proposed Project are identified as the follows:

- Review and approval of the technical, financial, and environmental feasibility of the proposed Project;
- Establish the preliminary and final detailed engineering plans (i.e. civil/structural, electrical, mechanical, and environmental protection features);
- Secure the necessary government clearances and permits (i.e. ECC, building permit, discharge permit, etc.)
- Conduct public information campaigns and consultation with the host communities and local government units;
- Purchase of available lands and compensation for affected properties;

- Provide traffic re-routing schemes or alternative access points for roads that will be directly affected by the construction of the proposed Project;
- Selection and awarding of designated project contractors; and
- Final agreement on funding arrangements.

14.4.2 Construction Phase

The construction phase of the Project can immediately commence upon completion of the pre-construction tasks. The major construction activities that MWSI will initiate, through its designated contractor, are the following:

- Establishment of construction work site, buffer zones, field office, and material/equipment storage;
- Land/site preparation (i.e. clearing of unnecessary vegetation and structures, soil compaction, site upgrading
- Construction of the STP primary structures and auxiliaries;
- Excavation and improvement of existing drainage/sewerage lines within identified areas of Parañaque and Las Piñas;
- Installation of various electro-mechanical equipment for the STP's (i.e. pumps, valves, lifts, compressors,) and conduits (i.e. electrical mains and power control boards,
- Commissioning and testing of the facilities.

The designated contractor must provide the necessary environmental protection and mitigation measures during the implementation of the various construction activities. These measures may include the following items:

- Equip the construction workers' camp site with adequate sanitation facilities (i.e. portable toilets, garbage bins);
- Establish a designated solid waste segregation and hauling area within the construction area;
- Implement worker and public safety programs by providing adequate precautionary lights/signages, safety devices, first aid kits, personal protective equipment (PPE);
- Install containment/security barriers along the perimeter of the construction site to minimize noise and dust propagation, as well as unauthorized access;
- Minimize unnecessary earth-movement and tree-clearing;
- Provide soil erosion and run-off controls;
- Establish worker and public safety programs; and
- Reduce/eliminate possible pollution sources.

14.4.3 Post-construction and Operations Phase

After the accomplishment of the various construction activities, the assigned contractor shall proceed in the demobilization procedures such as the following:

- Dismantling and removal of temporary structures which are unrelated to the future operations of the proposed Project (i.e. scaffoldings, construction workers camp, etc.)
- Segregation and proper disposal of construction spoils/debris, solid and liquid wastes, and hazardous items (i.e. spent chemical containers);
- Perform thorough inspection/checking, testing, and commissioning of the major structures, electro-mechanical equipment of the STP's and the pumping stations, drainage lines, and other utilities/auxiliaries.

The operations phase of the proposed Project shall be limited to the following:

Sewage Conveyance – This activity involves collection of raw sewage from various point sources (i.e. residential, commercial and industrial sources) through a network of combined drainage system. This is achieved by natural flow (i.e. gravity flow) or through pumping stations.

Sewage Treatment – Depending on the technology that will be applied, this involves biological treatment process supported by physical operation and chemical treatment.

Disposal of Treated Sewage and Sludge – This refers to the discharge of the treated effluent to the nearest receiving water body. The stabilized/dewatered sludge shall be treated on-site or delivered to a sludge processing facility.

Operations and Maintenance of Facilities – This involves the daily supervision and functioning of all the Project's facilities according to the designed/recommended procedures. This also entails regular repairs, replacement, and upgrades of equipment to ensure continuous and efficient operations.

14.5 Prediction of Impacts

14.5.1 Positive and Negative Impacts

The project, upon full-implementation, will provide significant positive impacts to environment and to the communities, most notably with the reduction of water pollution and water-borne diseases.

However, during the construction phase, and to a lesser extent during the post-construction/operational phase, it is inevitable that some negative impacts may be exhibited by the Project. These negative impacts are mostly short-term and reversible, which could be mitigated through proper application of enhancement controls.

Table 14-8 details the list of perceived and identified environmental impacts that could be generated upon the implementation of the proposed Project.

Table 14-8: Matrix of Environmental Aspects and Corresponding Impacts

Activity	Environmental Aspects	Potential Environmental Impacts	Parameter Most Likely to be Affected	Significance of Impact			
				+/- (positive/ negative)	D/In (direct/ indirect)	L/S (long-/ short-term)	R/I (reversible/ irreversible
A. Construction Phase							
A1. Construction of Sewage Treatment Plant & Pump Stations	Earth-movement and civil/ structural works	Disturbance and/or displacement of flora and fauna	Flora and fauna	-	D	L	I
		Increased erosion	Land	-	D	S	R
		Generation of construction spoils and debris	Land	-	D	S	R
		Restriction or alteration of drainage flow	Water	-	D	S	R
		Siltation and increased turbidity on the affected water body	Water	-	D	S	R
		Generation of dust	Air	-	D	S	R
	Influx of construction equipment	Ground vibration	Land	-	D	S	R
		Generation of air emissions	Air	-	D	S	R
	Influx of construction personnel	Generation of solid wastes	Land/Water	-	D	S	R
		Generation of domestic wastewater	Water	-	D	S	R
		Increased occupational safety & health risks	People	-	D	S	R
		Disturbance on peace and order	People	-	In	S	R
A2. Pipe Laying Activities / Laying of Primary & Trunk Sewers	Road and drainage excavation	Increase in traffic	People	-	In	S	R
		Generation of dust, noise, and ground vibration	People, Air, Land	-	D	S	R
		Siltation and increased turbidity on the affected water body	Water	-	D	S	R

Activity	Environmental Aspects	Potential Environmental Impacts	Parameter Most Likely to be Affected	Significance of Impact			
				+/- (positive/ negative)	D/In (direct/ indirect)	L/S (long-/ short-term)	R/I (reversible/ irreversible
B. Post-construction/Operations Phase							
B1. Operation and maintenance of STP and Pump Stations	Treatment of raw sewage	Generation of hazardous wastes (i.e. chemical containers)	Land, Water	-	D	L	R
		Increase in air emission and noise levels	Air	-	D	S	R
		Increased risks to occupational safety	People	-	D	S	R
		Possible contamination of nearby water bodies and groundwater	Water	-	D	S	R
		Generation of sludge and biosolid	Land	-	D	L	R

Note: Precise monitoring items and methodologies are shown in Annex 4A.

14.5.2 Socio-economic Benefits

The Project is expected to provide socio-economic benefits towards the cities of Parañaque and Las Piñas. These benefits include the following:

- Reduction of water pollution;
- Decrease in water-borne diseases and its associated costs to public health systems;
- Job generation;
- Appreciation of property valuation; and
- Possible increase in tourism activities.

14.5.3 Risk Assessment

Identification – In the assessment of the Project's risks to the environment, it is important to determine the possible risks that could be associated due to nature of the proposed Project's operations and the underlying environmental conditions in the area. **Table 14-9** lists the possible risks that could be associated with the proposed Project.

Table 14-9: Identified Possible Risks to the Proposed Project

Type of Risk	Possible Causes	Potential Effects
Fire	• Electrical short-circuits/ overloading of equipment • Human error (i.e. improper training and supervision of personnel)	• Partial or total loss of equipment and property • Injuries and fatalities to personnel/ public
Chemical spills	• Accidents on chemical handling and storage • Human error (i.e. improper training and supervision of personnel)	• Contamination of the surrounding soil and water bodies • Human, floral/faunal injuries and fatalities
Untreated sewage discharge	• Malfunction/failure of STP, PS, and other related structures • Human error (i.e. improper training and supervision of personnel)	• Contamination of the surrounding soil and water bodies • Human, floral/faunal injuries and fatalities
Occupational safety accidents	• Human error (i.e. improper training and supervision of personnel) • Malfunction/failure of equipment and facilities • Design deficiencies	• Partial or total loss of equipment and property • Injuries and fatalities to personnel/ public
Typhoons	• Location of the Philippines in a typhoon-prone area • Complex weather systems	• Intense rain and wind could cause partial or total collapse of lightly-built structures • Sewerage facilities could be overwhelmed by excessive amounts of rain • Injuries and fatalities to personnel/ public
Earthquakes	• Movement/rupture of nearby fault lines	• Failure of concrete structures • Injuries and fatalities to personnel/ public

Geological Hazards – Since the area of Parañaque and Las Piñas lies mostly in a flat terrain, the threat of landslides is negligible. However, some of the proposed Project's STP facilities (Options 3, 4, and 5) are located along Manila Bay and which could be exposed to wave erosion, especially during strong winds and during typhoon events. However, this could be managed by applying engineered shore protection and erosion controls.

Typhoon and Flood– The frequency of typhoons that affect the Philippines is about 20 per year. For Luzon Island, it has been reported that these areas experience about 3 direct and/or near direct typhoon landfalls.

With this condition, areas located near Manila Bay experiences strong storm surges that could severely affect/damage poorly-built structures. Also, water levels at the rivers and creeks that run through Parañaque and Las Piñas may also rise due to strong winds and storm surge that comes from Manila Bay. The rising water levels could also be worsened if the time of the storm surge occurs during high-tide.

Nevertheless, there were only few noted incidents in the past that Parañaque and Las Piñas were severely flooded due to typhoons.

Occupation and Public Safety Risks - During the Project's construction, various activities such as drilling, excavation, etc. present minimal to moderate safety risks to construction personnel and to the general public. These risks include the following:

- Falls, trips, and slips within and the immediate vicinity of the construction/excavation sites;
- Head and bodily injuries due to accidental construction material drops;
- Noise and dust nuisance;
- Exposure to hazardous chemicals; and
- Other possible injuries due to operation/maintenance of various equipment.

14.6 Mitigation Measures

Table 14-10 presents the mitigation and enhancement principles, practices, and technologies aimed at minimized and/or eliminating the potential impacts, as listed previously in **Table 14-8**, to its surrounding environment during the construction and post-construction/operational phases.

Table 14-10: Matrix of Environmental Aspects, Impacts, and Corresponding Mitigation and Enhancement Measures

Activity	Environmental Aspects	Potential Environmental Impacts	Mitigation and Enhancement Measures	Responsibility	Cost	Guarantees
A. Construction Phase						
A1. Construction of Sewage Treatment Plant and Pump Stations	Earth-movement and civil/ structural works	Disturbance and/or displacement of flora and fauna	• Perform earth-balling for applicable tree species • Avoidance of unnecessary vegetation clearing	Contractor	Part of construction costs	MOA / EMP
		Increased erosion	• Avoid long exposure of open soil to wind and flowing water	Contractor	Part of construction costs	MOA / EMP
		Generation of construction spoils and debris	• Use of excavated soil as backfill material • Segregation of solid wastes according to re-usable, recyclable, and disposal items	Contractor	Part of construction costs	MOA / EMP
		Restriction or alteration of drainage flow	• Provide a temporary diversionary channel to allow continuous water flow of drainage channels	Contractor	Part of construction costs	MOA / EMP
		Siltation and increased turbidity on the affected water body	• Avoidance of disposing excavated items, washing of concrete-mixing equipment in drainage	Contractor	Part of construction costs	MOA / EMP
		Generation of dust	• Minimize/prevent unnecessary earth-movement • Regular watering of construction areas that have high dust generation potential • Establish construction containment barriers/buffer zones	Contractor	Part of construction costs	MOA / EMP

Activity	Environmental Aspects	Potential Environmental Impacts	Mitigation and Enhancement Measures	Responsibility	Cost	Guarantees
A1. Construction of Sewage Treatment Plant and Pump Stations *(cont'd.)*	Influx of construction equipment	Ground vibration	• Apply non-vibrating methods (i.e. bored piling) for areas that are near concrete structures • Monitor possible ground instability within the vicinity of the proposed Project	Contractor	Part of construction costs	MOA / EMP
		Generation of air emissions	• Proper and regular maintenance of heavy equipment	Contractor	Part of construction costs	MOA / EMP
	Influx of construction workers	Generation of solid wastes	• Segregation of solid wastes according to re-usable, recyclable, and disposal items • Hauling of waste residuals by licensed waste service provider • Proper housekeeping at construction areas	Contractor	Part of construction costs	MOA / EMP
		Generation of domestic wastewater	• Establish a designated work area with sanitation facilities (i.e. portable toilets)	Contractor	Part of construction costs	MOA / EMP
		Increased occupational safety and health risks	• Provide construction personnel with adequate personal protective equipment • Supervision of civil and structural works • Provision of first-aid stations, safety equipment, and warning signages on working areas • Implementation of Emergency Response Plan	Contractor	Part of construction costs	MOA / EMP
		Disturbance on peace and order	• Establish a drug-free, anti-alcohol drinking, gambling, etc. system for construction personnel • Coordination with local police and peace and order councils	Contractor	Part of construction costs	MOA / EMP

Activity	Environmental Aspects	Potential Environmental Impacts	Mitigation and Enhancement Measures	Responsibility	Cost	Guarantees
A2. Pipe Laying Activities / Laying of Primary & Trunk Sewers	Road and drainage excavation	Increase in traffic	• Coordinate traffic procedures with the local barangay and city ordinances • All vehicles shall stay at the designated parking areas within the construction premises • Security personnel/traffic marshals will assist in directing traffic near the construction areas	Contractor	Part of construction costs	MOA / EMP
		Increase in noise and dust emission	• Excavate by segment and rehabilitate areas as soon as possible •			
		Siltation of drainage	• Collection and proper disposal of spoils • Store excavated materials properly			
B. Post-construction/Operations Phase						
B1. Operation and maintenance of STP and Pump Stations	Treatment of raw sewage	Generation of hazardous wastes (i.e. containers)	• Segregation of hazardous wastes from regular wastes • Storage of hazardous items on sealed, sturdy, and properly-marked containers	MWSI	Part of operations costs	MOA / EMP
		Increase in air emission and noise levels	• Establishment of air pollution controls fro genset • Proper maintenance of equipment to minimize noise and vibration • Capture of methane gas	MWSI	Part of operations costs	MOA / EMP
		Increased risks to occupational safety	• Provide personnel with PPE (i.e. goggles and masks) • Extensive training for selected personnel in handling and operating chemicals	MWSI	Part of operations costs	MOA / EMP

Activity	Environmental Aspects	Potential Environmental Impacts	Mitigation and Enhancement Measures	Responsibility	Cost	Guarantees
B1. Operation and maintenance of STP and Pump Stations *(cont'd.)*	Treatment of raw sewage *(cont'd.)*	Possible contamination of nearby water bodies and groundwater	• Proper operation of the STP to ensure discharge shall meet standards • Provision of containment barriers and spill response procedures in case of chemical spills	MWSI	Part of operations costs	MOA / EMP
		Generation excess sludge and biosolid	• Stabilize sludge prior to disposal through certified sludge treaters • Provide good sludge drying procedure	MWSI	Part of operations costs	MOA / EMP

14.6.1 Contingency/Emergency Response Plans

MWSI may develop an emergency response plan (ERP) specifically for the Project. ERP is based on the three principles, namely: preparedness, response, and recovery. These principles are defined as:

Preparedness – is the development of actual action plans in anticipation of emergency situations, elimination or reduction of risks/hazards from occurring.

Response – is the execution of the plans and procedures during an actual emergency event.

Recovery – is the retrieval of important assets, restoration of the site prior to the emergency, and performance of corrective actions.

The ERP principles are interconnected to form a cycle, upon which it provides MWSI a continuous program in improving its emergency preparedness and response.

MWSI shall focus more of its ERP efforts in preparedness. This is the development of actual action plans should an emergency happen, and elimination or avoidance of hazards from happening or occurring. This includes proper training of personnel, and ensuring that all the proposed Project's critical components are properly operated and maintained.

Inevitably, accidents may still happen through a combination of many causes, such as those previously listed in **Table 14-9**. For this instance, the execution of proper response procedures is the key in minimizing human injuries/fatalities, property losses, and damage to the surrounding environment. Proper response requires MWSI personnel to undergo rigorous training, provision of the necessary equipment, and adherence to certain protocols.

After the occurrence of an unfortunate emergency event/s at the Project Site, the next part of the ERP is the recovery phase. For this episode, MWSI shall evaluate the degree and scope of the aftermath of an emergency event, and perform the necessary corrective measures. This may also include compensation efforts to affected persons, and possibly remediation efforts if the surrounding environment is severely impacted. Thus, from this point on, after performing the recover procedures, the cycle of the ERP goes back again to the 'preparation' stage, to prevent/minimize such unfortunate happenings for re-occurring.

Moreover, the ERP may not only be limited to MWSI's own personnel and resources, due to the fact that some accidents may result to catastrophic consequences that may affect the general population. Thus, MWSI shall coordinate extensively with the concerned local government and rescue units, and may provide the formation of volunteer groups within the concerned communities to assist in the formulation of an effective ERP.

Table 14-11 presents the generic ERP that MWSI may adopt during certain types of emergency situations. A more detailed ERP may be devised in the future, to adapt to the existing conditions at the site.

Table 14-11: Contingency/Emergency Response Procedures for Different Scenarios

Preparation	Response	Recovery
A. Fire		
• Orientation and training of personnel on fire safety • Conduct regular fire drills • Installation and regular testing of fire-fighting devices (i.e. fire hoses, fire extinguishers, smoke detectors, sprinkler system) • Regular inspection of electrical equipment and lines and replacement as necessary, for any defects or malfunctions • Proper storage of all flammable items in secure and proper containers and storage facilities • Implementation of a 'no-smoking' policy in the STP's and pump stations • Placement of emergency numbers and communication equipments in conspicuous areas for easier notification • Emergency exits and evacuation procedures shall be put in place, and kept free from any obstructions • Regular maintenance of fuel/chemical tanks, piping, valves, and other related equipment	• Personnel are advised not to panic to prevent further injuries • Personnel are advised to follow emergency evacuation procedures • Report immediately any presence of smoke, sparks or open flame to authorized personnel • If the fire can still be contained, use fire extinguishers immediately • Disconnect electrical or fuel connections, and shut-down all affected equipment • If possible, remove all flammable materials from the fire scene to avoid further contact • For responders, wear the proper fire protection attire (i.e. fire suit, boots, breathing apparatus) • Avoid using or pouring water over fuel or chemical, and electrical fires, instead use foam or dry fire extinguishing agents • Response personnel are obliged to strictly follow response protocols and PPE usage	• Avoid returning to the fire scene, as long as necessary, unless declared for safe entry • Check personnel and find out if there are injuries or trapped/injured persons that may need assistance • Report any important incidents that require immediate attention • Secure important items and equipment from unauthorized access from outsiders, after the building is declared safe for re-entry • If the fire damage is minimal, or facility is recoverable, make necessary corrective measures to prevent the accident from re-occurring • Perform corrective measures on equipment and procedures
B. Earthquakes		
• Make necessary preparations, which includes equipment and facility checks to prevent injuries/facility failure in an event or an earthquake • All loose items must be secured to prevent falling • Placement of heavy materials near the ground • Storage of flammable items in designated safe areas • Personnel are familiarized to safe locations, emergency response equipment and evacuation routes • Identified downstream communities shall be informed about evacuations routes should dam breakage is imminent	• Personnel are advised not to panic to prevent further injuries • Personnel are advised to protect themselves by getting under sturdy structures • Personnel are advised to stay away from sharp, flammable, or heavy items • Personnel are advised to prepare immediate evacuation of the facility if necessary • All chemical/fuel lines and electric equipment will be shut down • If there is an imminent dam failure, issue an immediate alarm to downstream communities and their respective local government units to evacuate to safer locations	• If there are no threats of aftershocks, check other personnel that may be trapped, injured, or needs further assistance • Avoid returning to the facility if it is deemed structurally unstable, or declared unsafe • Conduct thorough inspection of the facility's premises for any unusual cracks/gaps in the ground or walls • Check for possible fires and advice authorities for appropriate response • Secure important items and equipment from unauthorized access from outsiders, after the building is declared safe for re-entry

Preparation	Response	Recovery
		• Inspect the facility for any major structural defects, cracks, and unstable items and other potential hazards • If the earthquake damage is minimal, or facility is recoverable, make necessary corrective measures to prevent the further hazards from affecting personnel and property • Perform corrective measures on equipment and procedures
C. Typhoons		
• Provision of sturdy roofing materials to minimize the effects of strong winds and rainfall • If there is a storm warning from PAGASA, monitor any possible developments especially for the expected forecast, path and intensity of the storm, and other important weather parameters • If there is a signal no. 2, normal operations ma y proceed however with extreme caution, and management may suspend operations depending on the developing situation • If there is a signal no. 3 or 4, all unnecessary activities are suspended automatically until weather conditions improve • Prior to the incoming storm, secure all loose items (i.e. lamp post, roofs, loose planks, and other light materials) by adding extra guy wires or reinforcing materials • Remove obstructions to the drainage system • Issuance of updates and warnings to the media regarding the current water levels	• Personnel are advised to protect themselves by getting under sturdy structures, and avoid staying outdoors • Personnel are advised to stay away from items that may be blown away by strong winds and electrical mains • Continuous monitoring of the weather conditions • If excessive rainfall prompts the reservoir to release water, issue an immediate alarm to the downstream communities and their respective local government units to evacuate to safer locations	• Inspect the facility for any major structural defects, cracks, and unstable items, other potential hazards • If necessary, repair broken power lines, fuel lines, and other utilities • Secure important items and equipment from unauthorized access from outsiders, after the facility is declared safe for re-entry • Perform corrective measures on equipment and procedures
D. Occupational Hazards		
• Regular maintenance of fuel/chemical tanks, piping, valves, and other related equipment • Provision of a bund/ retaining wall around chemical and fuel tanks to minimize the spread of contamination in case of leaks/spills • Avoid contamination of the	• Report immediately unusual odors, spills, and leaks to authorized personnel • Personnel are advised to maintain a safe distance from the actual leak/spill to prevent exposure (i.e. eyes/skin, ingestion, inhalation, slippage) • Response personnel are obliged to strictly follow response	• Perform corrective measures on equipment and procedures • Provide just compensation and rehabilitation to affected personnel

Preparation	Response	Recovery
chemicals • Proper training of personnel on chemical/fuel storage, handling, and spill containment • Installation of alarm/sensors on tanks • Avoid overfilling of chemicals/fuel and provide adequate clearance during filling procedures • Provision of spill boom, neutralizing agents, and other related spill-containment equipment • Posting of MSDS and safety signs at the vicinity of the chemical/fuel tanks • For chlorine leaks, the nearest community shall be advised on the possible evacuation zone	protocols and PPE usage • Containment equipment are immediately utilized around the spill/leak location • Chemical and fuel lines will be shut down • For chlorine leaks, identify the wind direction, and issue an immediate warning to the nearby community	
E. Chemical Spills		
• Regular maintenance of fuel/chemical tanks, piping, valves, and other related equipment • Provision of a bund/ retaining wall around chemical and fuel tanks to minimize the spread of contamination in case of leaks/spills • Avoid contamination of the chemicals • Proper training of personnel on chemical/fuel storage, handling, and spill containment • Installation of alarm/sensors on tanks • Avoid overfilling of chemicals/fuel and provide adequate clearance during filling procedures • Provision of spill boom, neutralizing agents, and other related spill-containment equipment • Posting of MSDS and safety signs at the vicinity of the chemical/fuel tanks • For chlorine leaks, the nearest community shall be advised on the possible evacuation zone	• Report immediately unusual odors, spills, and leaks to authorized personnel • Personnel are advised to maintain a safe distance from the actual leak/spill to prevent exposure (i.e. eyes/skin, ingestion, inhalation, slippage) • Response personnel are obliged to strictly follow response protocols and PPE usage • Containment equipment are immediately utilized around the spill/leak location • Chemical and fuel lines will be shut down • For chlorine leaks, identify the wind direction, and issue an immediate warning to the nearby community	• Perform corrective measures on equipment and procedures • Perform appropriate remediation and clean-up

14.7 Environmental Monitoring

The Environmental Monitoring Plan (EMoP) presents a set of critical environmental parameters that MWSI has to check regularly to ensure environmental compliance and operational sustainability. The EMoP allows MWSI to verify, examine, and perform the necessary corrective steps in mitigating the identified environmental impacts. The set of data that will be obtained during the EMoP implementation will provide the necessary information in examining the short- and long-term effects of the Project's various impacts, from which future strategies on enhancement measures can be formulated.

Table 14-12 details the matrix of the EMoP that MWSI may implement during the different phases of the Project's development.

Table 14-12: Matrix Summary of the Environmental Monitoring Plan

Concern	Parameter to be Monitored	Sampling Measurement Plan			Responsibility	Estimated Cost
		Method	Frequency	Location		
A. Pre-construction Phase						
A1. Area of land to be developed	Hectares	Land survey	Twice (preliminary and final survey)	Identified STP and pumping station sites	Design contractor	Part of design costs/ feasibility study
A2. No. of properties to be affected	Hectares of land, no. of built structures	Land survey	Twice (preliminary and final survey)	Identified STP and pumping station sites	Design contractor	Part of design costs/ feasibility study
A3. Public perception and acceptability	No. of valid concerns or complaints	Public consultation/ survey	Variable (depending on the	Affected local communities	MWSI	Part of design costs/ feasibility study
B. Construction Phase						
B1. Siltation of nearby water bodies	Water turbidity, sediments	Visual observation/ water quality sampling	Daily (for visual observation), monthly (for water quality testing)	Nearby affected water body	MWSI contractor	Minimal (for visual observation), PhP 5,000 to PhP 10,000 per water sampling activity
B2. Air quality	Dust and noise *Odor**	Digital sound level meter; **Subjective odor assessment*	Daily	Immediate vicinity of the construction sites	MWSI contractor	Minimal (for visual observation), PhP 5,000 air and noise sampling activity
B3. Occupational and public safety	No. of injuries, no. of safety man-hours	Log-book recording/ database registration	Daily	Within the construction zones	MWSI contractor	Part of construction costs
C. Post-construction and Operational Phase						
C1. Sewage intake and discharge	Volume (m^3) of raw and treated sewage	Meter reading	Daily	Within the STP and PS sites	MWSI	Part of operations costs
	BOD, COD, TSS, pH, heavy metals, oil and grease, surfactants, total coliforms	Laboratory analysis	Daily	Intake and outlet ports of the STP	MWSI	Part of operations costs
C2. Sludge generation	Volume (m^3) of sludge generated	Log-book recording/ weighing	Daily	Within the STP	MWSI	Part of operations costs
	Moisture content, heavy metals, total coliforms	Laboratory analysis	Weekly	Within the STP	MWSI	Part of operations costs

14.8 Conclusions and Recommendations

All proposed project options will impact the environment positively, most notably the water bodies surrounding Parañaque and Las Piñas. The main purpose of the Project, regardless where its components are built and operated, will reduce the amount of pollutants that degrade the water quality of the creeks, rivers, and portions of Manila Bay. The Project, once fully-established, shall improve the poor state of the waterways of Parañaque and Las Piñas. This in turn could result reduction of environmental and public health costs, thus improving the local economies of the community. The proposed Project's positive impacts on the environment outweigh the negative impacts.

The following is a summary assessment for Option 8 (the recommended option):

- The project areas are situated in a suitable geological and soil condition.
- The sites, on which the 11 installations will be constructed, are primarily built-up areas. This means that the ambient air and noise quality, and flora and fauna conditions in the area were already negatively affected prior to the Project. However, it is still the primary responsibility of MWSI to ensure that all safety practices are implemented to prevent further degradation of the surrounding environment.
- There are no indigenous people or illegal settlers that would be directly affected since most of the proposed sites are vacant lots.
- Five (5) out of 11 installations (STPs and PS) will be located in residential zones, as such special permits, clearances, and/or endorsements from the LGU and community organizations must be obtained.
- Nine (9) bodies of water were identified near the project impact zone, which could be affected positively or negatively, depending on the performance STP.
- STP No. 5 (ID No. P-6) is located near Manila Bay, which could be directly subjected to high winds and waves during typhoons.

15 SOCIAL-INSTITUTIONAL ASSESSMENT

This section provides a social impact assessment on the proposed Parañaque and Las Piñas sewerage project in order to determine the social safeguards that need to be addressed, particularly involuntary resettlement and compensation, before the project initiates any development activity on civil works, construction and other operation works.

15.1 Introduction

The general objective of the social assessment is to determine the potential negative impacts of the project's development activities on people and assets and draw up mitigating measures that will enhance social acceptability of the project. Specifically, the social study has the following objectives: 1) to provide guidelines to MWSI in undertaking a social impact identification of the project that will determine appropriate mitigating measures; and 2) to provide recommendations on activities that should be undertaken pertaining to social concerns in the different stages of this specific project.

15.1.1 Social Safeguard Compliance

In most infrastructure development projects, the potential adverse social impacts result in involuntary resettlement, land acquisition and right-of-way (ROW), and damage to or loss of assets. If the project impact should cause any or all of these concerns, appropriate mitigating measures should be in place. With reference to international policies (i.e., JICA, ADB, & World Bank) on social safeguards compliance specific to assess social impacts of the project, **Table 15-1** describes the different categories of social safeguards compliance.

Table 15-1: Matrix of Social Safeguard Compliance

Social Impact	Compliance	Project Stage
A. Involuntary Settlement		
Category 1: 0 person or household (Hh)	None	Pre-construction
Category 2: At least 1 indigenous person	Indigenous Peoples' Development Plan	Pre-construction
Category 2: 1 – 200 persons or 1 – 50 Hhs	Abbreviated Resettlement Plan	Pre-construction
Category 3: >200 persons or >50 Hhs	Full Resettlement Plan, External Monitoring Agency	Pre-construction All project stages
B. Land Acquisition/ROW		
Donation	Perfected Deed of Donation	Pre-construction
Negotiated Purchase	Deed of Sale	Pre-construction
Expropriation	Writ of Possession	Pre-construction
Easement of ROW	ROW Easement Agreement	Pre-construction
Usufruct	Usufruct Agreement	Pre-construction
Lease	Lease Contract	Pre-construction
C. Damage/Losses		
Structures	Compensation/Assistance/ Restoration	Pre-construction
Crops/Trees	Compensation/Assistance/ Plan	Pre-construction
Livelihood	Compensation/Assistance Plan/Income Restoration Plan	Pre-construction

15.2 Social Safeguard Policies and Laws

The social safeguards appropriate for the adverse project impacts are anchored on existing GOP laws and executive orders as described briefly in **Table 15-2**.

Table 15-2: Summary of Social Safeguard Policies and Laws

Policies and Laws	Brief Description
World Bank Policy on Involuntary Resettlement	• Requires the avoidance of project-related displacement of people wherever/whenever feasible. • A Resettlement Plan must be prepared in instances where loss of assets, resources, homes, or livelihood is unavoidable, to ensure that livelihood and quality of life are restored at least to prior standards. • Per World Bank policy, when there are more than 200 people or 50 households affected, a full resettlement plan is required. One to 200 people or 50 households affected by the project, an abbreviated resettlement plan is required.
GOP 1985 Executive Order 1035	• Land acquisition to be based on fair market value to be negotiated between owner and appraiser. • Financial assistance to displaced tenants, cultural minorities and settlers equivalent to the average annual gross harvest for the last 3 years and not less than P15,000 per hectare, • Disturbance compensation to agricultural lessees equivalent to 5 times the average gross harvest during the last 5 years. • Compensation for improvements on land • Government has power to expropriate in case agreement is not reached.
Supreme Court Ruling 1987	• Defines just compensation as fair and full equivalent for the loss sustained, taking into account improvements, location, capabilities, etc. • The value given by the appraiser can only serve as a guide for negotiation. The objective is to enable the Displaced Person to replace affected assets at current market price.
Republic Act (RA) No. 6389	• Provides for disturbance compensation to agricultural lessees equivalent to 5 times the average gross harvest in the last 5 years.
RA 7279 Urban Development and Housing Act of 1992	• Provides guidelines for resettlement of persons living in danger areas, e.g. riverbanks, shorelines, and waterways or areas where government infrastructure projects are about to be implemented. Guidelines cover the provision of basic services and facilities in resettlement sites, livelihood support, meaningful participation and adequate social preparation for the affected households, close coordination between sending and host LGUs, grievance, redress and related aspects. • Informal settlers who built their houses on or before the effectivity date (March 28, 1992) are entitled to all benefits and considerations prescribed in the said act.
RA 8974 of 2000	• Aims at ensuring that owners of real property acquired for infrastructure projects are promptly paid just compensation. It also provides for the compensation of affected improvements and structures at replacement cost (without depreciation and inclusive of labor costs for reconstruction) and the arrangement of independent appraisers for a more accurate determination of the market values of lands and improvements.

15.3 Social Impact Assessment

Social impact assessment (SIA) is a validation of the “likely impacts” of the project. MWSI should conduct an assessment of the positive and negative impacts of the project especially to the affected community, and identify all types of possible risks involved. Some projects that are initially conceived as beneficial may have adverse socio-economic, environmental and cultural impacts, which may be easily overlooked. It is in the process of social impact assessment that these concerns are carefully addressed with the participation of various stakeholders through consultations, focus group discussions, and key informant interviews especially those that will be affected by the project. In the broad spectrum, social impacts would also include:

- Gender impacts: that the project would not have a disproportionate negative impact to both women and men; in other words, the effect of the project would be gender balanced and sensitive;
- Social impacts: those on the social fabric of the community and well being of the individuals and families; and
- Impact to vulnerable groups, including the informal settlers.

15.3.1 Initial Assessment Checklist

An Initial Social Impact Assessment checklist is provided in エラー! 参照元が見つかりません。 **15-3** to determine if the project has adverse social impacts that require social safeguards compliance.

Table 15-3: Checklist of Project-affected Persons and Assets

Type of Social Impact	Response		Details
	Yes	No	
Land acquisition necessary	√		Size & use of land
HHs / Persons will be displaced		√	No PAP identified
Presence of informal settlers		√	No PAP identified
Legal structures acquired/damaged	√		No., size & built of structures
Informal structures being removed	√		No PAP identified
People losing means of livelihood		√	No PAP identified
Basic services will be inaccessible		√	Not applicable
Crops trees being damaged/lost	√		No. & type of crops / trees
Tenant /Lessees losing crops/trees		√	Not applicable
Informal settlers losing crops/trees		√	Not applicable
Indigenous peoples* to be displaced * refers to cultural minorities or tribal group (e.g. aeta, bagobo, manobos, etc)		√	Not applicable
Cultural property affected		√	Not applicable

15.3.2 Social Impacts of Various Project Components

The social impact of the project is based on the technical components and scope of work of the project. The scope of work covered by the proposed project includes the following:

- Sewage Treatment Plant with facilities and related works like pump stations, offices, etc;
- Access road; and

- Right of way for STP and sewer lines.

Based on the identified project components of the project, an initial social impact assessment is presented in エラー! 参照元が見つかりません。.

Table 15-4: Initial Social Impact Assessment of the Project Components

Project Components	Potential Social Impact	Social Safeguards Compliance
Construction of STP; pump stations and office;	• Land Acquisition; • Involuntary Resettlement • Damage to property • Prohibition of human activities that limit livelihood opportunities • ROW acquisition	• Land Acquisition (through the help of the local government) documentation should be accomplished prior to construction • Full or Abbreviated Resettlement Plan • Compensation Plan • Livelihood Restoration Plan
Installation of structures and excavation and pipe-laying	• Destruction of structures, transfer or removal of trees.	• Compensation Plan • Restoration Plan • Community Assistance

15.3.3 Social Development Plan

A community-based Social Development Plan (SDP) will be developed through a series of consultation with various sectors of the project affected communities in the barangay through the assistance of barangay and city councils, and the government agencies to be led by Community Relations Group of MWSI.

The objectives of the SDP include the following:

- Identify the basic needs and welfare of the community as basis for the framework of social development programs of the project affected barangays within the project site;
- Prepare an indicative sustainable plan based on the Barangay Development Plans and the mandated support of MWSI; and
- Establish a working relation with MWSI and the various community stakeholders with the goal of improving the quality of life of the project affected community by enabling them to becoming self reliant.

The community-based consultation during the development of the SDP also provides an opportunity for identifying the following:

- Addressing key issues and concerns by the various stakeholders;
- Identifying and designing the recommend measures in response to the issues and concerns raised;
- Identifying the lead agency or organization responsible in implementing the measures; and

- Setting of timelines to implement these measures consistent with the plans and programs of the lead agencies.

The information collected from the community perception survey and consultation will also form part of the SDP that mainly address the following issues:

- Perceived fears of environmental degradation or public nuisance due to pollution of land, air, water and resources, and health risks;
- Possibility of losing their homes; and
- Possibility of losing their source of livelihood.

A proposed indicative SDP for this project is presented in **Table 15-5**.

Table 15-5: Proposed Social Development Plan for the Project

Concern	Responsible Community Member/ Beneficiary	Government Agency/Non-government Agency and Services	Proponent	Indicative Timeline	Source of Fund
1. Relocation (if necessary)	Barangay Chairman Families to be displaced	LGU – City Assessor based on cadastral survey	MWSI Legal Officer	• Pre-construction	MWSI
2. Gender Responsive Livelihood / Employment • Job opportunity and local hiring • Skills training for both qualified and unqualified workers	Association Chairperson • Affected Men, Women, Youth & Elderly	• LGU – City Planning Office • TESDA • Funding of small livelihood projects • Provide materials for training	MWSI HR and Community Relations Group	• Construction • Operation	LGU, MWSI
3. Health and Safety	Barangay Kagawad for Health	CHO • Provide water and sanitation services • Barangay Disaster Management Training	MWSI HR and Community Relations Group	• Construction • Operation	LGU, MWSI
4. Environment and Sanitation • Brgy Solid Waste Management Plan	• Barangay Kagawad for Environment • Project Affected Community	CPDO / ENRO • Solid waste management program • Health programs- CHO • Sanitation services	MWSI HR and Community Relations Group	• Construction • Operation	LGU, MWSI
5. Peace and order	Barangay Kagawad for Peace and order	LGU / PNP • Capacitate and Strengthen Barangay Tanods in peace keeping	MWSI HR and Community Relations Group	• Construction • Operation	LGU, MWSI

15.4 Perception Survey

A perception survey was conducted from March 25 to 29, 2011 at the cities of Las Piñas and Parañaque. One of the key objectives was to meet with the Local Officials in the barangay level to discuss the future Sewage Treatment Plant (STP) of the MWSI. Part of the discussions with the barangay officials is the location of the proposed sewerage project and the advantages that it would bring about to the communities in the different barangays, namely: Barangays Manuyo Dos, Pamplona Dos and Tres, Pulang Lupa Uno and Dos, San Dionisio, Tambo, Baclaran Santo Niño and Moonwalk.

Another key objective of this trip is to conduct a random survey of the local barangay officials from different barangays in the two cities through consultations and discussions who may be directly impacted by the project.

Based on the survey conducted, it reflected a relatively low awareness of the respondents to the proposed project. But for those who are aware, survey showed that their sources of information were through their neighbors/friends, barangay officials, and laborers/staff of the project. Majority of the respondents agreed that the proposed project will be beneficial. Perceived benefit was basically for health improvement. Other benefits include mitigation of water pollution and improvement of the community. But some of the respondents are not aware of any benefit yet. Job employment, good water source and conservation of water were suggested by the respondents as perceived benefits. As for the perceived effects of the proposed project, some are not yet aware of any negative effect the project may cause them. But some said that the project will not cause any negative effect to the community. A few of the respondents perceived that the project may cause water pollution, health problems, or may cause the residents near the river be relocated.

The respondents gave suggestions regarding the proposed project such as to give importance on the health in the community, to implement the rules and regulations on constructing the STP, to provide relocation programs in case there will be displacement of households or settlers in the area. The survey also showed that the respondents are strongly in favor with the proposed project

Based on the survey conducted, it reflected that 98% of the respondents strongly favor the proposed STP project (refer to **Figure 15-1**). The results of the perception survey are detailed further in **Annex 5**.

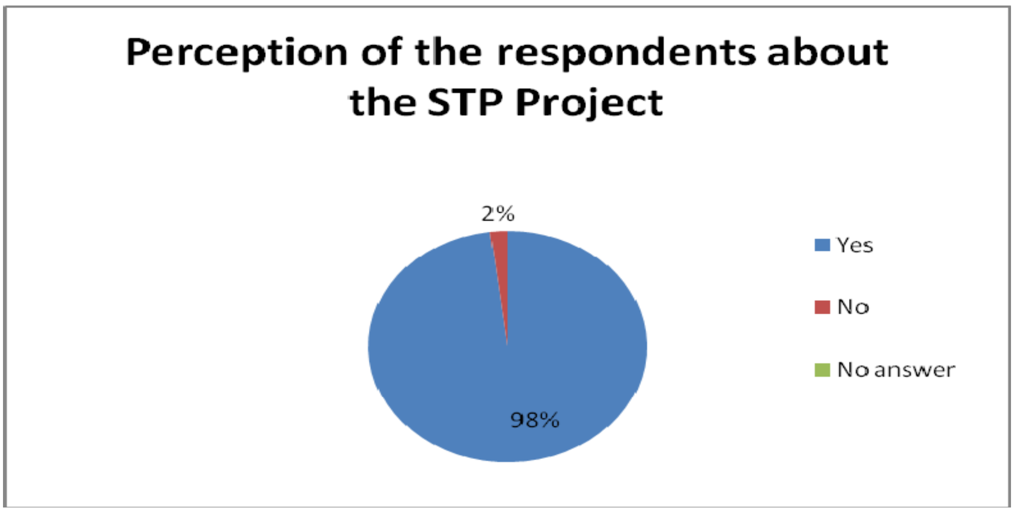

Figure. 15-1 Perception Survey results

15.5 Social Impacts and Mitigation

The key feature of the SIA process is the conduct of a social investigation. Of equal significance is the conduct of stakeholders' interview, as well as the conduct of focus group discussions (FGD's). Observations provided relevant insights too. The tools and instruments used are to ensure appropriateness to the unique conditions obtaining in the project's situation located in the affected barangays of Parañaque and Las Piñas.

The SIA aims to determine the social impact (positive and negative) of the proposed project and to facilitate the creation of appropriate response mechanisms to ensure social desirability and acceptability through the following:

- Identify positive and adverse impact of the proposed project on the people and their communities, especially focusing on the marginalized sector;
- Determine the level of awareness, and facilitate the actual participation, of significant stakeholders on the proposed project; and
- Propose mitigating measures that will alleviate possible adverse impacts on project-affected people and communities, and ensure sustainability of these measures

15.5.1 Construction Phase of the STP

- **Population Settlement/Migration** – For all the technical options considered, there will be no household that will be evicted, relocated or resettled. It is possible that transient workers from other barangays or neighboring areas may temporary increase as a result of the construction in the project site.

- **Employment and Livelihood Opportunities** – The proposed project will require workers and personnel for its construction. Skills such as engineers, office personnel, heavy equipment operators, electricians, utility workers and laborers will be required during the construction phase.

  As part of the Contractor's Social and Environment Program, MWSI may require its contractors to give priority to local qualified applicants from the impacted barangays. MWSI may ensure the equitable distribution in the allocation of the manpower requirement among the various barangays in the host cities. Livelihood opportunities in support of the project construction will be created independent of the project. Requirements of the employees, workers and the proponent will be developed by the residents because of the increase demands. Residents engaged in these activities are expected to improve their standard of living because of additional income for their families.

- **Health and Sanitation** – With the various construction activities, it is likely that dust particles, possible accidents resulting from passing of trucks during construction, and air emissions by trucks and heavy equipment during the construction phase will pose health hazards. The incidences of respiratory diseases and allergies may increase in residents whose houses are located near the project site. Likewise, the demand for water supply and access to sanitation and waste disposal facilities will increase because of the presence of workers and personnel during construction phase. Moreover, during construction phase, the workers will generate solid waste from their personal and construction activities.

A water sprinkling system will be adopted in excavation areas to minimize the generation of air borne dust particles in going into the neighboring areas. The construction workers should have adequate protection devices to minimize inhalation of dust particles and fumes. The contractors through the MOA shall be compelled to maintain their heavy equipment and vehicles in top condition.

- **Local Taxes and other Benefits to the Local Government Units** – The host barangays will directly benefit from the project because of the local taxes, permits and licenses that will be due from the construction phase of the project. This additional revenue will be shared by the LGUs and its host barangays and may be appropriated to improve the delivery of basic services such as education, health, road maintenance, water supply and police services.

15.5.2 Operational Phase of the STP

- **Employment and Livelihood Opportunities** – The proposed project may offer employment and livelihood opportunities to the residents of the host barangays to augment their income.

- **Women's Welfare** – Women entrepreneurs will have a lot of opportunities to market their wares that are mostly in the service areas of food, beverages, and communication (cell card loads). Laundry services may also be an option but should be gender sensitive.

- **Additional Revenues to Las Piñas and Parañaque Local Government Units –** The LGUs will directly or indirectly benefit from the project implementation through additional revenues generated by the project. As in the construction phase, they will also directly benefit from the project because of the local taxes that will be due from the operational phase of the project. This additional revenue may be appropriated to improve the delivery of basic services such as education, health, road maintenance, water supply and police services.

15.5.3 Recommendation for Future Activities

The success of any development project depends largely on social acceptability. Hence, social preparation begins with consultations with the project-affected people and the project beneficiaries in general. Since there are no critical issues in this particular project at the moment, consultation can focus on project orientation to increase the people's awareness of the MWSI's plan to improve and develop an efficient sanitation and sewerage services in the area. By educating them on the various advantages of an improved sanitation system and its positive impacts, it will be easier for them to understand if there will be social and economic benefits to stakeholders. On the other hand, the directly affected people will be given sufficient information on its socio-environmental impact to the identified pilot areas.

Prior to construction and when the social impact assessment of the project is finalized, appropriate social safeguards should be planned and implemented in constant consultation with the directly affected people.

15.6 Land Acquisition and Resettlement

The proposed Project may involve purchasing lands/properties that are currently owned privately, or in some cases, informal settlers are located. Thus a Land Acquisition and Resettlement (LAR) plan may be necessary to be performed by MWSI.

The objective of LAR is to ensure just compensation and peaceful and effective resettlement of the households/families to be affected by the proposed Project.

15.6.1 Legal Framework

The LAR will be governed by existing Philippine laws and regulations for the protection of the rights of families who will be displaced by the proposed Project. It will also be guided by the MWSI's environmental and social policies specifically for projects experiencing adverse impacts and for affected persons living within the impact areas.

- **1987 Philippine Constitution** –The 1987 Philippine Constitution provides the overall mandate that describes the inherent and inalienable right of all Filipinos. Article III Section I states that *"no person shall be deprived of life, liberty or property without due process of law, nor shall any person be denied the equal protection of the laws."* On the other hand, Article II, Section 9 states that *"private property shall not be taken for public use without just compensation."*

- **Land Valuation and Compensation (RA No. 8974)** – RA 8974 intends to facilitate the acquisition of the right-of-way, site or location for national government infrastructure projects; and prescribes the modes of land acquisition procedures, expropriation and compensation. The policy declares that the state shall ensure that owners of real property acquired for national government infrastructure projects are promptly paid with just compensation. It also provides for the compensation of affected improvements and structures at replacement cost (without depreciation and inclusive of labor costs for reconstruction) and the engagement of independent land appraisers for a more accurate determination of the market values of lands and improvements. It provides for the following standards in the determination of the fair market value of land:

    - The classification and use for which the property is suited;
    - The development costs for improving the land;
    - The value declared by the owners;
    - The current selling price of similar lands In the vicinity;
    - The reasonable disturbance compensation for the removal and/or demolition of certain improvements on the land and for the value for improvements thereon;
    - The size, shape or location, tax declaration and zonal valuation of the land;
    - The price of land as manifested in the ocular findings, oral as well as documentary evidence presented and;
    - Such facts and events as to enable the affected property owners to have sufficient funds to acquire similarly-situated land of approximate areas as those required from them by the government, and thereby rehabilitate themselves as early as possible.

- **Executive Order No. 1035** – This provides for the procedures and guidelines for the expeditious acquisition by the government of private real properties or rights thereon for infrastructures and other government development projects such as, but not limited to the conduct of feasibility study, public information campaign, parcellary survey and assets inventory.

  It also sets the guidelines for government acquisition of private properties for development purposes, either through negotiated sale or expropriation, and provides for compensation for lost crops of displaced tenants.

- **Urban Development and Housing Act of 1992 (RA No. 7279)** – This Act describes and defines disturbance compensation and when this would be given as compensation to people relocating and resettling brought by infrastructure and other development projects.

  Its IRR details the procedures and guidelines for proper and humane relocation and resettlement operations as mandated by RA No. 7279.

15.6.2 Classification of Settlers/Affected Persons

- **Registered Title Holder** – People who are holders of certificate of title issued by a court of law on the Bureau of Lands, Land Authority, and/or by the Department of Agrarian Reform on or before a date where MWSI will publish announcement regarding expropriation of and compensation for properties in the proposed Project site/s.

- **Tenant** – It is defined through reference to appropriate provisions of RA No. 3844, the Agricultural Land Reform Code, as the following:

  - Agricultural Tenancy - the physical possession by a person of land devoted to agriculture belonging to, or legally possessed by, another for the purpose of production through the labor of the farmer and of the members of his immediate farm household, in consideration of which the farmer agrees to share the harvest with the latter, or to pay a price either in produce or in money, or in both" (Sec. 3, Part 1, RA 1199);
  - Share Tenancy - means the relationship which exists whenever two persons agree on a joint undertaking for agricultural production wherein one party furnishes the land and the other his laborer, with either or both contributing any one are several of the items of production, the tenant cultivating the land personally with the aid of labor available from workers of his immediate farm household, and the produce thereof, to be divided between the landholder and the tenant." (Sec.166:25, Chapter XI RA 3844);
  - Leasehold Tenancy - exists when a person who, either personally or with the aid of labor available from members of his immediate farm household, cultivate a piece of agricultural land belonging to or legally possessed by another in consideration of a fixed amount in money, in produce or in both (As amended) (Sec. 4, Part I, RA 1199) "Share Tenancy was established by RA No. 3844. (Sec. 4, Chapter I);
  - Government Title Holder - agency or instrumentality of the government which may own land or may have introduced improvements in the proposed Project area;

- Government Permit Holder - an agency or instrumentality of the government holding a Special Land Use Permit (SLUP) authorizing the use of inalienable or alienable and disposable public lands for specific purposes or the introduction of improvements within the boundaries defined therein and;
- Unregistered Land Owner - a person who is the owner of a parcel of land that is not registered with the Register of Deeds under the Torrens system of land registration as evidenced by such documents as a parcellary survey defining its boundaries, a deed of sale from the previous owner, a property tax declaration on file with the offices of the municipal and provincial assessors, and other documentation that may be provided, such as affidavits of owners of adjacent parcels and local officials.

15.6.3 Process of Land Acquisition

The following summary of ROW Acquisition Procedures (Purchase Option), based on RA No. 8974 of 2000 and some excerpts the Department of Public Works and Highways (DPWH) Ministry Order No. 65, Series of 1983, entitled "Revised Guidelines on the Acquisition and Payment of the ROW for Public Works and Highways Projects:"

Step No. 1 – For the negotiated sale, a Contract of Sale is executed between the MWSS/MWSI (vendee) and the Property Owner (vendor).

Step No. 2 – When a project is already approved for implementation during a specified calendar year, the officials in charge with the ROW acquisition shall immediately gather all tax declarations and corresponding sworn statements of owners relative to all lots and improvement affected by such construction.

Step No. 3 – The owners of the property shall be notified in writing and the just compensation to be paid for the affected properties shall be based on the Standards for the Assessment of the Value of the Land as provided for in Section 5 of R.A. No. 8974.

Step No. 4 – The Deed of Sale is prepared. The requirements and conditions to be complied with the preparation of the Deed of Sale as follows:

- If the subject property is registered or titled, the vendor must be the registered owner of the said property and must possess a clear and clean title under the Torrens System, free of any lien and encumbrances whatsoever. A photocopy of the title forms part of the Deed;
- If the subject property is unregistered or untitled, the vendor must submit a certified true copy of the tax declaration and an indemnity bond, which must be either a surety bond or property bond. Either of these bonds shall remain in force until the government obtained the corresponding title to the subject property;
- If the owner of the property is a corporation, a certified true copy of the resolution of the governing board of such corporation or partnership, authorizing any of its officers to execute the deed shall be attached to the said deed. In the case of a partnership, the managing partner should execute the deed;
- If the owner of the company is already deceased, the heirs must first consolidate their ownership of the property either thru court proceedings or thru an extra-judicial settlement, subject to the provisions of Rule 74 of the New Rules of Court;

- If the property is under guardianship or administratorship, approval by the proper court of the deed of sale executed by the guardian or administrator/executor must first be secured. The corresponding Letters of Administratorship and/or Guardianship should be submitted as an integral part of the Deed;
- If the property being sold was acquired under Public Land Act, the government shall be entitled to a twenty (20) meter strip fee under Section 112 of CA 141, or sixty (60) meter strip under P.D. 635 (January 7, 1975);
- If it appears that the property is subject to the provisions of Section 4 Rule 74 of the New Rules of Court and the period of two (2) years from the registration of the consolidation or settlement has not yet expired, an indemnity bond (either surety or property bond), conditioned for the payment of any adverse claim against the property filed within the said period of two (2) years, should be posted;
- If the vendor is represented by an Attorney-in-Fact, the corresponding Special Power of Attorney should be attached to, and made an integral part of the deed of sale. If the vendor is residing abroad at the time of the sale, such Special Power of Attorney should be duly attested by the Philippine Consulate of the country where the vendor resides;
- Where the subject property is mortgaged, the consent of the mortgagee to sale of the said property, or release of the mortgage must first be secured;
- If the property is a conjugal property, a deed of conveyance or sale must be executed in the proper form by the parties concerned, specifically describing the property to the sold. The marital consent of the spouse of the owner-vendor should generally be indicated in the deed; the deed of conveyance must be witnessed by at least two persons and if the vendor affixed his signature by thumb mark, same should be witnessed by two additional persons;
- All realty estate taxes due on the property must have been paid as evidenced by a tax clearance certificate issued by the proper authority;
- The accountant concerned should also witness the contract, and his signature shall be considered as constituting a certification that funds for the purpose is available and;
- The papers and documents submitted in support of the claimant every case should be carefully verified as to their authenticity in order to forestall fraud.

Step No. 5 – A Certificate of Availability of Funds in the proper form, duly verified by the auditor concerned, indicating the particular source and nature of the funds to be used in payment of the **consideration** of the sale, must be secured and attached to the deed (Section 607, Revised Administrative Code and Section 86 of PD No. 445).

Step No. 6 – The ROW engineer, in addition to verifying the ownership of the lot to be purchased, as well as any encumbrances to which such lot may have been subjected to, should likewise verify and inspect the actual lot to be purchased to determine whether the classification made by the Assessor is in accordance with the actual use of the property (Section 19, PD No. 464). A certification to this effect should be issued by the ROW engineer;

Step No. 7 – The Deed of Sale is signed by the Owner of the property, the Project Manager.

Step No. 8 – The signed Deed of Sale is brought to the MWSS/MWSI for final approval.

Step No. 9 – The approved Deed of Sale is then registered with the Registry of Deeds of Parañaque and Las Piñas where the property is located.

For the payment of claims, there are certain conditions prior to the release of payments which include the following:

- Payment of lots should be effected only after the corresponding Deed of Sale had already been registered with the Registry of Deeds concerned and Torrens Title to the subject lot is already vested in the name of the government. For parcel of lands partially affected, payments should be effected only after the corresponding Deed of Sale had already been annotated at the back of the subject lot;
- If the Deed of Conveyance was not signed by the owner but was signed by his duly and legally constituted agent, the owner should also be notified in writing of the amount due him as payment of his property. Accordingly, the treasury warrant or check for the payment of said property should be drawn in favor of the registered owner; and
- Officials or employees responsible for releasing checks or warrants should require positive identification of the payee before releasing the checks or warrants.

15.6.4 Value of Improvements/Structures

A Valuation Committee will be organized to assess the value of the improvements and/or structures on the land to be acquired using the replacement cost method. The replacement cost of the improvements/structures is defined as the amount necessary to replace the improvements/structures, based on the current market prices for materials, equipment, labor, contractor's profit and overhead, and all other attendant costs associated with the acquisition and installation in place of the affected improvements/structures. In the valuation of the affected improvements/structures, the valuation committee will consider, among other things, the kinds and quantities of materials/equipment used, the location, configuration and other physical features of the properties, and prevailing construction prices.

15.6.5 Compensation and Entitlements

- **Residential and Commercial Land Owners** – The title holder will be entitled to cash payment or land-for-land compensation. The new replacement land must be of equivalent size or at least a size acceptable to the owner, with adequate physical and social infrastructure. As in agricultural lands, replacement land would be free from taxes, registration, and transfer cost.

  Where the relocation is necessary, the MWSS/MWSI in consultation with the affected households may offer relocation option to fully developed resettlement sites, or alternative facilities to housing projects. The replacement land for resettlement will be provided in fixed plot to sizes in accordance with existing zoning laws and practices. If the lost land is larger than the lot sizes for relocation, the affected land owner is entitled to receive cash compensation to cover the difference.

- **Residential Land Tenants/Renters -** Residential tenants or renters are entitled to cash compensation equivalent to one (1) month rental allowance, and assistance in transferring to a new location. For tenants who built their own house, they will be entitled to be compensated in full for their affected house or structure, paid the transport allowance, and assisted in finding another site. The level of assistance will depend on the type of existing tenurial status of the affected communities.

- **Trees Lost** – Owners of the trees lost shall be entitled to cash compensation calculated on the basis of type, age, and productive value of affected trees. For fruit-bearing trees, payment shall be based on tax declaration or schedule of values from the Office of the City Assessor. For perennials of commercial value, valuation can be based on DENR schedule of valuation or concerned Appraisal Committee.

- **Informal Settlers** – Informal settlers or squatters who built their own house shall be entitled to compensation in full for their affected house or structure, without deduction for salvaged building materials. Professional squatters can collect salvaged materials but will not be entitled to receive compensation.

16 REGULATORY REVIEW

This section reviewed important rules and regulations governing sewerage and sanitation undertakings in the Philippines which may be applicable to the proposed sewerage project in Parañaque and Las Piñas. It also enumerated pertinent provisions of recently passed laws and administrative orders that may have impacts on the development and implementation of existing and future sanitation and sewerage projects of MWSI.

Reviews on the Clean Water Act and the *mandamus* issued by the Supreme Court of the Philippines on the Manila Bay cleanup were discussed in relation to the possible impacts on the on-going and future undertakings of MWSI. The MWSS Concession Agreement (CA) with MWSI, which in April 2010 was extended up to 2037, was also reviewed focusing on the revised targets that must be complied by MWSI in terms of sanitation and sewerage coverage.

16.1 Applicable Environmental Laws

The national legislative framework for sanitation and sewerage projects in the Philippines is governed by three (3) main laws, namely: (1) Presidential Decree (PD) No. 856 or the Code on Sanitation of the Philippines, (2) Republic Act (RA) No. 9275 or the Clean Water Act (CWA), and PD No. 1586 or the Philippine Environmental Impact System (EIS) Law.

These laws are supported by a number of implementing rules and regulations, procedural manuals and administrative orders.

16.1.1 The Code of Sanitation of the Philippines

The Code of Sanitation of the Philippines (PD 856) was promulgated in December 23, 1975 by then President Ferdinand E. Marcos. Since its promulgation, it has been the basis of rules and regulations imposed for health and sanitation. The Department of Health (DOH) issued (in 1995 and supplemented in 2004) the implementing rules and regulations (IRR) for its Chapter XVII providing the detailed requirements on the collection, handling, transport, treatment and disposal of sewage, domestic sludge and septage.

In 2008, the DOH issued the Operations Manual for Chapter XVII prescribing the approved methods of handling, transport and treatment of domestic sludges and septage from sewerage treatment plants (STPs) and septic tanks, respectively.

The IRR and its supplemental apply to all individuals, firms, public and private operators, owners and administrators engaged in the collection, handling and transport, treatment, and disposal of excreta and sewage and domestic sludge from cesspools, communal septic tanks, Imhoff tanks, domestic sewage treatment plants/facilities and septage from household septic tanks.

Some of the key provisions of the Sanitation Code on sewage and sewerage systems include:

- Sewage disposal shall be by means of a municipal or city sewerage system whenever available.
- Where a public sewerage system is not available, sewer outfalls from residences, schools, and other buildings shall be discharged into a septic tank.

- The treated effluent of septic tanks may be discharged into a stream or body of water if it conforms to the prescribed quality standards (now prescribed by DAO 35 series of 1990).
- Properly designed grease traps shall be provided for sewers from restaurants or other establishments where the sewage carries a large amount of grease.
- Septic tanks in new subdivisions are prohibited unless the site is considered to be impractical and inadvisable to install a public sewage collection system with the required treatment.
- Septic tanks shall be cleaned before excessive sludge or scum is allowed to accumulate and seriously reduce settling efficiency. Septic tanks shall be inspected at least once per year and be cleaned when the bottom of the scum mat is within 7.5 cm of the bottom of the outlet device or the sludge and scum has reduced the liquid capacity by 50% (estimated between 3 to 5 years).
- Storm water shall be discharged to a storm sewer, sanitary sewage shall be discharged to a sewerage system carrying sanitary sewage only; but this should not prevent the installation of a combined system.
- Effluents of industrial plant should meet the standards set by DENR and all other regulatory agencies. Appropriate permits should be secured by the industrial plant from DENR.
- All wastes incident to the operation of the industrial plant shall be collected, stored, or disposed of in a manner to prevent health hazards, nuisances, and pollution. Where a city or municipal collection and disposal system exists, it should be utilized (Chapter VII – Industrial Hygiene).

The 2004 Supplemental IRR of the Code prescribed some of the procedures on domestic sludge and septage handling. Some key provisions of this supplemental include:

- Section 3 specifies that any individual, firm or operator, government or private, who are engaged or will be engaged in the collection/de-sludging, handling, transport, treatment and disposal of sludge and septage is required to secure Environmental Sanitation Clearance (ESC) prior to operation. The ESC shall be issued by the Secretary of Health or the Director of the concerned Center for Health Development (CHD) as his duly authorized representative.
- The ESC application will require the operator's submission of project description (including handling, transport, storage, treatment and disposal operations) and some environmental baseline information of the project site such as topography, geologic condition, and hydrology.
- Proper septage and domestic sludge collection and transport system, including vehicle registrations and specifications i.e., vehicle must be enclosed with leak proof body and lock.

16.1.2 The Clean Water Act

The Clean Water Act (CWA) primarily addresses the abatement and control of pollution from land-based sources and covers all water bodies such as fresh, brackish, and saline waters, and includes but not limited to aquifers, groundwater, springs, creeks, streams, rivers, ponds, lagoons, water reservoirs, lakes, bays, estuarine, coastal and marine waters. Section 3, Rule 3 further stated the CWA applicability to marine pollution and disposal of effluents on land including the transport and disposal of effluent, sewage and septage offsite, whether offshore and on land.

The CWA was the basis of the Supreme Court decision on the case of MMDA and other government agencies versus concerned residents around Manila Bay where a *mandamus* was issued for the immediate cleanup of the bay.

The CWA enables the creation and delegation of new regulatory, planning and infrastructure development functions to agencies and subsidiary multi-sectoral bodies (water quality management boards) and on streamlining inter-agency coordination. The integration of water quality management framework will be achieved through coordination of functions of various agencies and by designating water quality management areas (WQMAs). The formation of WQMAs is in recognition of the fact that water pollution occurs within spatial scales. The CWA directs the DENR and the National Water Resources Board (NWRB) to designate WQMAs based on general ecological/hydrological, meteorological or geographic criteria rather than in accordance with existing political boundaries.

A Governing Board will administer the WQMA. The governing board will be composed of representatives of LGUs, relevant national government agencies, non-government organizations (NGOs), water utility sector, and business sector. The Governing Board is primarily tasked to oversee implementation of the WQMA action plans and review and revise the plans, as necessary. In addition, each management area can create a multi-sectoral group to conduct surveillance and monitoring.

Another key feature of the CWA is the institutionalization of the wastewater charge system as well as an effluent trading system as market-based instruments (MBIs) to promote waste minimization and encourage companies to invest in clean production technologies.

- **WQMA for Parañaque and Las Piñas** – Through a recent project under the Manila Third Sewerage Project (MTSP), Parañaque and Las Piñas will soon be designated under one WQMA. Initial meetings on the creation of the governing boards have been conducted last December 2010. Key stakeholders, including MWSI representatives, were invited. After a technical secretariat is formed, a water quality management action plan will be developed to comply with the CWA requirements.

This MWSI sewerage project for Parañaque and Las Piñas will be an integral component of the WQMA action plan and shall be a milestone commitment of MWSI being part of the Technical Secretariat. The creation of the WQMA for Parañaque and Las Piñas will facilitate the implementation of this project with the support of various stakeholders including the local chief executives of the two LGUs.

- **WQMA Fund** – To finance the clean-up and containment operations and rehabilitation of affected water bodies, research, enforcement, and monitoring activities, a water quality management fund will be established after the WQMA for Parañaque and Las Piñas has been created. Funds will be sourced primarily from discharge fees. The national implementing rules and regulations governing the WQMA fund are now being finalized by EMB with some clarifications raised with the Department of Budget and Management (i.e., mechanisms on the transfer of funds from the national treasury to the WQMA fund).

16.1.3 The Philippine Environmental Impact Statement (EIS) System

PD 1586 or the Environmental Impact Statement System established a landmark policy that required projects with potential impacts on the environment to obtain an Environmental Compliance Certificate (ECC) as a prerequisite for implementation.

Under the EIS System, a project proponent is tasked to undertake an environmental impact assessment (EIA) study and to prepare an Environmental Impact Statement (EIS) or an Initial Environmental Examination (IEE), depending on the scope of the project. The EIS/IEE is a written report containing an assessment of the most likely impacts of the project on the environment and on the people in the areas to be affected by the project. The EIS/IEE is submitted to the DENR for review and forms the basis for the approval or denial of the project's ECC application.

PD 1586 was further strengthened by DENR Administrative Order (DAO) No. 37, series of 1996, DAO No. 30, series of 2003 and Memorandum Circular (MC) No. 2010-14. These refinements have clarified procedures for screening and scoping of projects, and expanded the application of the EIS system to programs (co-located or similar projects).

Sewerage project, although considered as environmental enhancement initiatives, will still be covered by the EIS system. Projects on sewage collection, transport, treatment, and disposal are required under DAO No. 30 to submit the IEE Checklist report which is a simplified form designed by DENR to assist proponents in complying with the EIS system. But depending on the scale of the project, the auxiliary activities (i.e., extensive pipe laying, large treatment plants, etc) and other intervening environmental and social factors), the document required may be elevated to either IEE or a full-blown EIS. Focus will be given on the activities during construction and sewer pipe-laying as well as the residual wastes during STP operations. An environmental management plan (EMP) and an environmental monitoring plan (EMoP) are usually integrated to contractor's agreement and scope of work.

16.1.4 Relevant Regulatory and Permitting Requirements

The permits/clearances required for projects related to sanitation, sewerage system, and sewage/septage treatment plants, grouped according to the implementation stage, (i.e., pre-operating and operational phases) of the project are listed in **Tables 16-1**.

Table 16-1: Matrix Summary of Rules and Regulations Pertinent to the Regulated Wastes from Sanitation and Sewerage Projects

Regulated Wastes	Relevant Laws, Rules, and Regulations	Remarks
A. Liquid Wastes		
Effluents of individual/ household septic tank	PD 856 – Sanitation Code • 1995 IRR of Chapter XVII	• Guidelines for design and maintenance of septic tanks • Whenever available, sewage disposal must be by means of municipal sewerage system
	RA 9275 – Clean Water Act	• Mandatory connection to existing sewerage system
Effluents of communal septic tanks, sewage treatment plants (STPs), septage treatment plants	PD 856 – Sanitation Code • 1995 IRR of Chapter XVII	• Procedures for design approval, construction, operation, and maintenance

Regulated Wastes	Relevant Laws, Rules, and Regulations	Remarks
(SpTPs), and outfalls		
	RA 9275 – Clean Water Act • Provisional DAO 35 series of 1990	• Secure discharge permit after payment of wastewater discharge fee • Unauthorized dumping of untreated sewage is prohibited • Effluents must comply with provisional DAO 35 or the Philippine effluent standards
Domestic wastes from offshore sources	PD 979 – Marine Pollution Law	• Unauthorized dumping of untreated sewage is prohibited • Sea dumping is regulated by Philippine Coast Guard
Effluents for recycling/re-use	RA 9275 – Clean Water Act	• Department of Agriculture shall set guideline for safe re-use of wastewater for irrigation and agricultural purposes.
B. Septage/ Bio-solids and other Solid Wastes		
Septage from individual household septic tank	PD 856 – Sanitation Code • 2004 IRR of Chapter XVII	• Requirement of Environmental Sanitation Clearance for operators involved in collection, handling, treatment and disposal of septage • Mandatory processing and treatment of septage prior to disposal • Recommended treatment processes and disposal methods
Biosolids from STPs and SpTPs	PD 856 – Sanitation Code • 2004 IRR of Chapter XVII RA 9275 - Clean Water Act	• Department of Agriculture through the Bureau of Soils and Water Management shall establish allowable and acceptable limits for nutrients, heavy metals and pathogens.
Preliminary treatment residues i.e., oil and grease, grits and screenings	RA 9003 – Ecological Solid Waste Management Act • DAO 2001-34	• Compliance to disposal and transport to sanitary landfill
C. Air Pollutants		
Conventional air pollutants from stationary sources i.e., PM, CO, SO_2, NO_x from generator set	RA 8749 – Clean Air Act • DAO 2000-81	• Secure permit to operate for air pollution source installation • Compliance to National Emission Standards for Source Specific Air Pollutants (NESSSAP)
Odor (specific malodorous compounds such as methane)	RA 8749 – Clean Air Act • DAO 2000-81	• Compliance to National Emission Standards for Source Specific Air Pollutants (NESSSAP)
Noise	NPCC Rules	• Compliance to ambient noise standards

Table 16-2 lists the permits that are required for projects related to sanitation, sewerage system, and sewage/septage treatment plants, grouped according to the implementation stage (i.e., pre-operating and operational phases). An initial environmental examination (IEE) checklist is provided in **Annex 4a**.

Table 16-2: Environmental Permitting Requirements of Sewage/Sanitation/Septage Projects

Regulatory Permit	Issuing Agency	Remarks
A. Pre-operating Phase		
1) Environmental Permits		
Environmental Compliance Certificate (ECC) supported by Initial Environmental Examination (IEE) Report or Environmental Impact Statement	Regional/Field Office DENR-EMB	In accordance with the procedural requirements of the EIS systems. For projects located in Environmentally Critical Areas.
Permit to Import Hazardous Chemicals	DENR-EMB and Bureau of Customs	Allows importation of hazardous chemicals
Permit to Cut Trees	DENR Regional/Field Office	For projects that will cut trees
2) Other Related Permits		
Certificate of Land Title	Registry of Deeds	Proof of land ownership
Certificate of Lease Agreement	DENR Regional/Field Office	Proof of transfer of right to use for an agreed period of time and amount of rent
Foreshore Lease Agreement		For contract leasing of foreshore lands covering different sizes: below six hectares, more than 50 hectares
Special Land Use Permit	DENR Regional/Field Office	For land use of areas of different sizes: areas up to 50 hectares but less than 100 hectares; areas of 100 to 500 hectares; areas more than 500 hectares.
3) Building and Construction Permits		
Building Permit	Local government unit (LGU)	Ensures plans and specifications of project conform with the requirements of the Building Code
Clearing/Fencing/ Excavation Permits		Permit to start construction activities
Authority for Electrical/Mechanical Installations		Allows installation of electrical and mechanical works consistent with the Building Code
Sanitary Permit		Attests building / structure conforms with good engineering and sanitation practices
Certificate of Occupancy		Attests compliance of finished structure/building with the Building Code
Mayor's Permit and Locational Endorsement		Business Permits of the project
B. Operational Phase		
1) Environmental Permits		
Environmental Monitoring Fund (EMF)	MOA between DENR and MWSI	For the operational expenses of the Multi-partite Monitoring Team (MMT) and analysis of samples. The revolving fund is replenished by the Client and managed by the MMT Executive Committee.
Permit to Operate (P/O) for Air Source Emission / Air Pollution Control Facilities	DENR Regional/Field Office	For the operation of air source emission and air pollution control facilities such as generator sets
Discharge Permit	DENR-EMB	For discharge of effluent into a body of water, i.e.,

Regulatory Permit	Issuing Agency	Remarks
		Pasig River, Laguna Lake, Manila Bay, etc.
Interim Permit for Handling, Transport and Disposal (TSD) of Toxic and Hazardous Wastes	DENR - EMB	For generation, disposal, and transport of hazardous wastes from the plant site
2) Other Related Permits		
Environmental Sanitation Clearance / Sanitation Permit	Department of Health (DOH)	For the maintenance of sanitary conditions in the facility
Fire Protection Permit	LGU	For the maintenance of fire-protection devices and implementation of safety measures in plant site
Solid Waste Disposal		For the collection and disposal of solid wastes generated by the plant.
Occupational Safety and Health	Department of Labor and Employment (DOLE)	For the protection and promotion of safety and health of the employees in facility

16.1.5 Procedure in Environmental Compliance Certificate Application

As discussed previously in **Section 16.1.3**, the proposed sanitation Project would need an ECC. The ECC application and issuance process are summarized in **Figure 16-1**, and further detailed in **Figure 16-2**. The ECC processing is stipulated in DAO No. 2003-30.

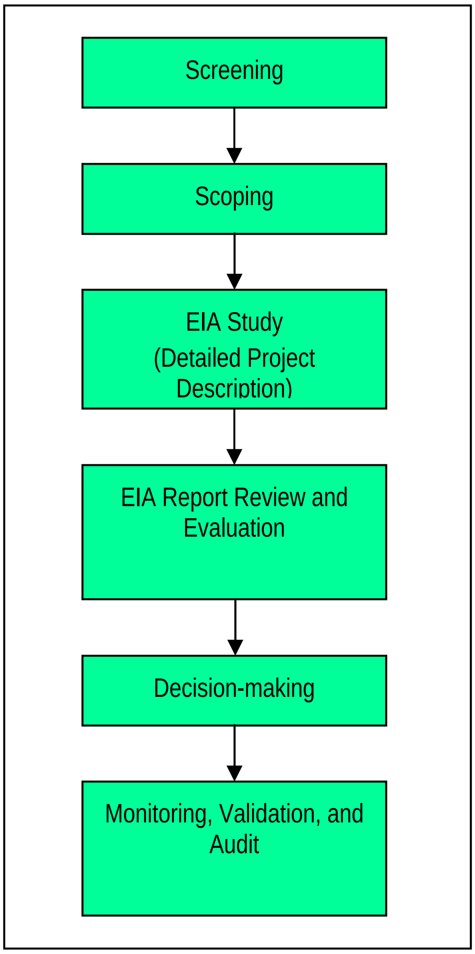

Figure 16-1: Overview of the EIA Process

- **Screening** – This process determines if the proposed sanitation/sewerage project for Parañaque and Las Piñas is covered by the EIS system. Afterwards, the proponent shall be advised by the EMB to either prepare/submit an IEE or an EIS document.

- **Scoping** – This step, if determined necessary by the EMB, is a proponent-driven activity. This is where significant aspects, impacts, and stakeholders for the proposed Project are identified. The EMB will also advise the proponent, and whether a Review Committee (REVCOM) and Public Consultation are necessary.

- **EIA Study and IEE/EIS Report Preparation** – This is the stage where the information obtained during the screening and scoping stages of the EIA, the project description, baseline environmental conditions and impact prediction, environmental management and monitoring plans, and other-related EIA topics are integrated together and documented properly. The format and outline of the report are specified in the DAO No. 2003-30.

- **Evaluation** – After the EIA documentation, the report shall be submitted to the EMB for review of the agency, or in other cases, by the designated REVCOM. This is also where additional information may be required from the proponent to further clarify pertinent issues/comments that could be raised during the review process.

- **Decision-making** – This is the stage where the ECC for the Project is either approved or denied by the EMB. If an ECC application is denied, the proponent shall be given a timetable to appeal or make the necessary adjustments to comply with the prescribed regulations. If the ECC application is approved, the EMB shall state the necessary conditions for the proponent in order to maintain environmental compliance and project sustainability. Once the ECC (together with the issuance of other document requirements/permits) is finally granted, the proposed Project can start its implementation.

- **Monitoring, Validation, and Audit** – This post-ECC stage confirms the proponent's performance on environmental compliance, as well as verification of the implementation of the mitigating and monitoring plans in minimizing the proposed Project's impacts.

With reference to Section 2 of MC No. 2010-14, the EIS/IEE report document to be submitted to the EMB should contain at least the following supporting documents:

- Proof of compatibility to existing land use plan of the host city/municipality;
- Proof of ownership or authority on the project site (i.e. land title, lease agreement);
- Accountability statements of the project proponent and EIS/IEE preparers, as specified in DAO 2003-30;
- Duly-accomplished Project Environmental Monitoring and Audit Prioritization Scheme (PEMAPS), as specified in DAO 2003-30.

According to Section 6.2 of MC No. 2010-14, all environmentally-critical projects (ECPs) and non-environmentally-critical projects (non-ECPs) shall have a maximum processing timeframe of 40 and 20 working days respectively, prior to the issuance of the ECC. The processing timeframe of ECC application starts after the receipt of the application document and payment of the necessary fees.

Environmental and Social Scoping Report as Input to EIA

The Initial Environmental and Social Scoping Report (as detailed in **Annex 4**) was used in the analysis of the various technical options of this project. This report provided basis in decision making for recommending the best options and what are the environmental considerations that must be taken into account.

After MWSI approve the final technical option presented in this FS, (i.e., approval of the specific sites of the STP), the ECC application process may now be started. It must be noted that the Philippine EIS system is site specific. Hence, the final pipe alignment as well as the locations of the STPs and pump stations must already be established prior to the start of the ECC processing with the DENR-EMB.

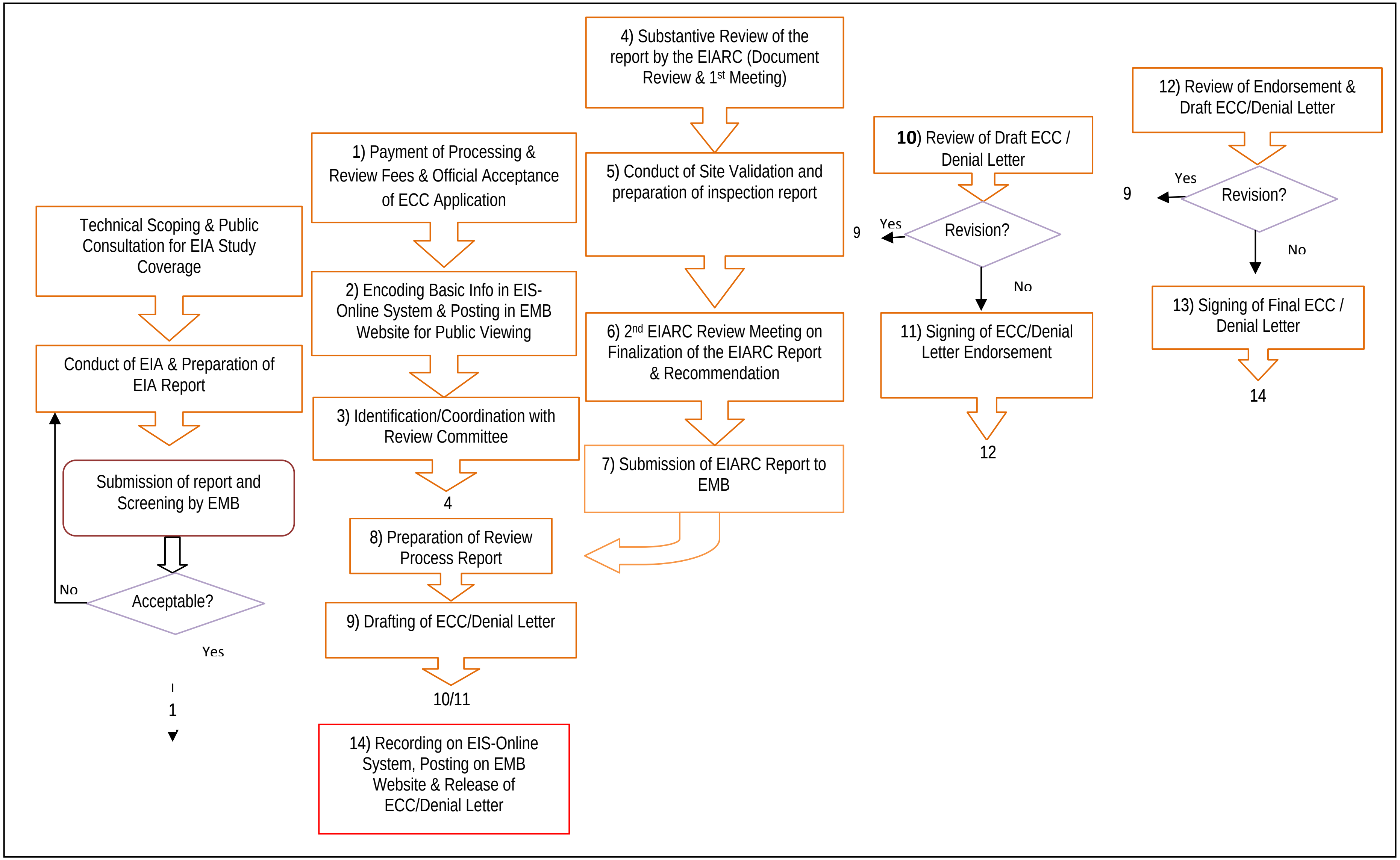

Figure 16-2: Detailed Flow Chart of the EIA Application, Review, and ECC Issuance (Source: DENR 2003-30 Procedural Manual)

16.1.6 Environmental Monitoring Fund and Environmental Guarantee Fund

As stated in Annex 3-5 of the DAO No. 2003-30, an environmental monitoring fund (EMF) may be required by EMB from the proponent during the development/operation of the Project. The EMF is a budget necessary to support the activities of the multi-partite monitoring team (MMT). An EMF is only applicable for EIS-based projects, whose amount shall be decided upon by the EMB and will be different from one project to another.

From Annex 3-6 of the DAO No. 2003-30, an environmental guarantee fund (EGF) shall be **required for projects that have been determined by the EMB to pose significant public risks, or** the project requires rehabilitation/restoration (i.e., resource extractive projects). The EGF is often applied to on/off-shore drilling and mining projects.

16.1.7 Wastewater Charge System and Drainage Permits

Governing Principles of the Wastewater Charge System – The CWA directs the DENR to prepare a wastewater charge formula which will consider the following:

- Provide strong economic inducement for companies to modify their production or management processes or to invest in pollution control technology in order to reduce the amount of water pollutants generated;
- Cover the cost of administering water quality management or improvement programs;
- Reflect damages caused by water pollution on the surrounding environment including the cost of rehabilitation;
- Type of pollutant;
- Classification of the receiving water body; and
- Other special attributes of the water body.

The implementation of the wastewater charge system shall be implemented in all areas including Parañaque and Las Piñas.

Formula for the Wastewater Charge System – The previous permitting system does not mention the volume and concentration of wastewater discharge, except for the Environmental Users Fee System of the Laguna Lake Development Authority (LLDA). With the CWA, the volume is now considered in the computation of the fee.

The discharge fee in the proposed formula is based on a net waste load which considers the situation that water to be used by a facility already contains certain pollutants and therefore the discharge fee will be based on the net wastewater load to be discharged. If the water source is loaded with certain pollutants, the industry or locator will be charged only based on what has been added (pollutant) to the river or coastal water quality.

The computation of the wastewater discharge fee will be based on the following formula:

$$\boxed{\mathbf{WDF = Ln \times R}}$$

where:

R - is the rate per kilogram (PhP/kg) which is initially fixed at PhP5.00 per kilogram for priority pollutants (BOD or TSS)
Ln -refers to the net waste load (kg/year)

The net waste load, Ln is computed further as follows:

$$\boxed{\mathbf{Ln_{(BOD5/TSS)} = [(C_f - C_a) (Q_f \times N_f)] \times 0.001}}$$

where:

C_f - is the average daily effluent concentration limit (mg/L) for priority pollutant parameter
C_a - is the average water quality concentration limit for priority pollutant parameter of abstracted or intake water (mg/L)
Q_f - is the average daily volumetric flow rate or final discharge effluent (m^3/day)
N_f - is the total number of discharge days in a year (days/year).

The variable component is based on the net waste load to be computed from each type of pollutant. Initially, the BOD will be used in the formula for wastewaters that have high organic or biodegradable materials and the TSS concentration will be used for high inorganic or non-biodegradable materials. PhP 5.00 per kilogram BOD or TSS shall be charged.

Later on, the DENR can expand the coverage of the wastewater charge system to cover other pollutants. However, this would be done only after due consultations with the affected sectors. In non-attainment areas, the DENR shall prioritize application of the charge system on criteria pollutants that have exceeded guideline values.

Currently, EMB has limited capacity to validate all industry discharges, hence, would tend to rely on the reports by the regulated community. EMB will compute based on the projected load on the permit and the submitted self monitoring report (SMR). If there is a huge variance from the projected load due to change in technologies, etc., then, the regulated company will need to prove the reduction in waste load through inspections and self-monitoring reports. This change will be factored in the wastewater discharge fee for the succeeding year.

Discharge fee is computed on an annual basis which will be paid in advance by the company. If the company shows significant difference on the basis of the computation, then, the company must prove the variance to get the reduction.

16.2 CWA Issues on Sanitation and Sewerage

16.2.1 Impact of CWA on Domestic and Commercial Effluents

The following are the major provisions in the CWA that would have impacts on domestic and commercial effluents:

- Domestic and commercial establishments are required to connect sewage outfalls to existing sewerage systems. Although MWSS does not have the authority to sanction establishments that refuse to connect, the CWA now allows the DENR to initiate actions against these establishments in coordination with the LGUs and even DOH.
- Domestic and commercial establishments that are not connected to existing sewerage systems of MWSI should treat their own effluents and comply with the Effluent Standards outlined in DENR Administrative Order No. 35.
- Disposal of septage or domestic sludge should comply with the standards and guidelines issued by the DOH.
- Disposal of sludge through land application should comply with the standards of the Department of Agriculture.
- Use of low-cost sanitation options to augment the sewerage program is encouraged and promoted in the CWA.

16.2.2 Impact of CWA on Industrial Effluents

The provisions that would have an impact on industrial effluent are the following:

- Mandatory connection of sewage lines to existing sewer lines; and
- Pre-treatment standards for industrial sources that would discharge into the sewerage system needs to be developed by MWSS.

16.2.3 Mandatory Connection to Sewer Lines

Under the CWA, the MWSS through its concessionaires should provide the sewerage and sanitation facilities and enforce the mandatory connection of sewage lines from domestic, commercial or industrial establishments to available sewerage system.

In doing so, the accountability in terms of compliance with the effluent standards and the payment of wastewater discharge fee will rest with MWSI as operator of the sewerage system.

In the case of commercial and industrial companies, MWSI may develop discharge standards to sewers to account for the pre-treatment of wastes.

16.2.4 Sanctions for Refusal-to-Connect to Existing Sewer Lines

The provision on mandatory connection in the CWA basically supplements the Sanitation Code. Despite the presence of this provision in the Sanitation Code, there is resistance to connect due to the following:

- MWSS/MWSI has a policy that the house owner shall pay for the sewer connection (tapping to sewer lines) even in the street area with surface restoration; and
- The sewerage charge of 50% on the water bill is only imposed if the houses are physically connected. From the 2008 MWSI Business Plan, MWSI will lower the sewerage charge to 20% for residential and 40% for non-residential from 2009 to 2012. The sanitation charge will remain at 20% for all non-sewered areas.

In implementing the mandatory connection to existing sewerage system based on the CWA, the MWSS/MWSI should clearly identify commercial and industrial establishments and households connected to existing sewerage systems. MWSS is not mandated to take any action against establishments refusing to connect into the system under the CWA. Meanwhile, the DENR can initiate sanctions against an establishment that would fail to connect to available MWSI sewer lines in coordination with LGUs and DOH.

Sanctions would include the following:

- DENR can withhold permits or deny the issuance of an ECC;
- DENR can request LGUs and other agencies in writing about the sanctions for the establishment based on applicable laws; and
- DOH can refuse the issuance of the Environmental Sanitation Clearance.

The sanctions that would be initiated by DENR are relatively considered as low-impact actions in terms of implementing the mandatory connection of establishments. Given the constraints and resistance to connect, this particular provision of the law may face difficulties in implementation. Development of guidelines for this particular provision is necessary to strengthen the enforcement and define the roles that other government agencies may render.

16.2.5 Pre-treatment Standards

Under the CWA, pre-treatment standards can be recommended by MWSS and/or MWSI to DENR to manage effluents (i.e., commercial and industrial effluents) that are channeled into sewerage systems. In the absence of pre-treatment standards, the MWSS/MWSI can impose pre-treatment standards to establishments tapped into their system through contract with the particular establishment (i.e., limit on BOD or oil and grease concentrations in the wastewater discharged through the MWSI sewer lines).

Since commercial and industrial wastes vary from domestic sewage, MWSS/MWSI may need to evaluate whether their STPs can accommodate these sources of pollution. In this case, the design of the sewage treatment facilities should take into consideration pre-treatment standards and appropriate surcharges for non-compliance with the pre-treatment standards.

A fee system should be designed and set-up by MWSS to regulate quality from commercial and industrial sources that would be channeled into the sewerage system.

16.2.6 Compliance with Effluent Standards

The sewage treatment facilities of MWCI/MWSI are required to comply with the guidelines on sanitation of the DOH and the Effluent Standards of DENR. The same standards apply for domestic, commercial or industrial effluents.

In the interim, DAO No. 35 applies as the Effluent Standards while DAO No. 34 will serve as guideline for the water usage and classification and water quality criteria.

The EMB will soon release an updated Philippine Effluent Standards with more stringent effluent limits on nutrients particularly nitrates and phosphates. The designs of the proposed STPs must consider these new requirements. If there is a need, existing treatment plant must be upgraded to be able to treat these nutrients adequately.

The CWA prescribes the penalty of PhP10,000.00 to a maximum of PhP200,000.00 per day of violation due to non-compliance to effluent limits.

16.2.7 Other Issues Relative to the MWSS/MWSI Plans and Programs

Conflict with LGU's in Imposing Fees – The CWA underscores the role of the LGU in presenting priorities for sewerage and septage management. LGUs are mandated to maintain and shoulder the maintenance drainage systems for the case of combined sewerage system. It is further stated in the CWA that LGUs may enact ordinances to impose service fee system on sanitation and sewerage services. The CWA creates mechanisms for funding through a fee system – property taxes and sewerage system. However, this may duplicate the fee being charged by MWSI, hence, this may need further review/study.

The fact that the CWA gives the LGUs the responsibility for the provision of rights-of-way and road access, the importance of local political support should likewise be emphasized. However, the imposition of fees to locators should be clearly defined with the LGUs.

The Concession Agreement stipulates in Article 7, Rule 7.2 (Easements, Eminent Domain, Right of Way and Similar Powers) the following:

"MWSS hereby appoints the Concessionaire as its agent and representative, for purposes of, among others, Section 3(k) of the Charter, in its name, place and stead, to apply for and exercise its easement, eminent domain, right of way and similar rights and powers given to MWSS under its Charter in connection with infrastructure projects and works undertaken relating to the Concession by the Concessionaire in the Service Area pursuant to this Agreement. The Concessionaire shall be solely responsible for the payment of any compensation to third parties occasioned by the exercise of such rights and powers."

While the MWSS can insist on implementing the right to eminent domain as embodied in its Charter, the important role of the LGUs in the implementation of sewerage projects should be taken into account.

Although Metro Manila LGUs have already a long history of good cooperation with MWSS, a pass-on fee to LGUs may be discussed to resolve any potential conflict that may occur with LGUs due to this particular provision of the CWA.

Incentives to Connect to Existing Sewer Lines – While the CWA reinforces the provision on mandatory connection of the Sanitation Code, the sanctions designed in the CWA are considered as low-impact and may once again face the usual resistance from consumers of MWSI. The MWSS needs to discuss with the DENR and DOH stringent sanctions and more importantly attractive incentives to consumers to connect to the sewerage system.

Water Supply Disconnection – CWA stipulates that the DENR Secretary may issue an order to the Local Water Districts or to private water supplier such as MWSI to disconnect the water service of a violator of any provisions of the CWA. This particular rule may need further legal analysis by MWSS and the issuance of appropriate guidelines by the DENR.

16.3 Review on the Concession Agreement

The concessionaire's agreement with MWSS shall basically be reviewed because of their contract closing period has been extended from original year 2021to year 2036. Subsequently the contents affected by extension of the contract agreement would be duly modified. Because of several sewerage treatment projects are now under bidding or construction by both MWSI and MWCI. Regarding sewerage and sanitation improvement project for Parañaque and Las Piñas is still under preparatory study; however, several technical proposals are made in the report, especially combined collection sewer system has made MWSS change their basic policy from separate sewer application to combined sewer application as economical and fast realization of sewerage and sanitation system development in Metro Manila, even though their final system of sewer collection is still separation sewer application as their final choice.

The combined sewer to be applied to sewerage treatment systems applied to Parañaque and Las Piñas Cities should be taken consideration together with their new contract agreements caused their contract agreements' extension.

The following items in the current agreements would be requested to keep in step with this project's alternatives to be proposed.

Article 5.

5.2 General Obligations Regarding the Provision of Sewerage Services

5.2.1 Supply of Sewage Service; New Connections

5.2.2 Obligation to Make Connections to a Public Sewer

These items are made on premise of separate sewer line systems. Obligation or new connections should be modified assuming combined sewer system would be mainly developed in future.

5.2.4 Septic and Sanitation Cleaning

This item asks concessioners to provide septic tank cleaning service at regular intervals of five or seven years. However, as sewerage system services develop, the cleaning interval should be shortened.

6.6 Disconnection

Tariff unpaid customers would be disconnected their service connections after pre-notice, however, in case of combined sewer service, sewage tariff unpaid should be a reason to suspend water supply by the concessioners.

Schedule 3 and 4

Sewerage services for Paranaque and Las Piñas are planned to cover poorly by the business plan. The percentage development plan should be re-modified

17 CONCLUSIONS AND RECOMMENDATIONS

The preparatory survey for Metro Manila sanitation and sewerage improvement project – Phase 2 conducted in the eight months period beginning June 2010 was aimed to develop the most feasible Project that would reduce pollution to water bodies by the expansion of wastewater treatment and facilities management towards an improved environment. The salient project features, issues and concerns, conclusions and recommendations from the Study are summarized hereunder.

17.1 Issues and Concerns

This preparatory survey report concludes and recommends the viable proposals for sewerage and sanitation system development projects to be established in Parañaque and Las Piñas Cities which would likely be accepted by the stakeholders, such as relative agencies like LGUs, DOH, DENR, NEDA, DPWH, etc., MWSS or MWSI as the proponent and also entrepreneur, local residents, and so on. However, there would be also hurdles, obstacles, hampers or obstructions to be overcome.

17.1.1 Financial and Budgetary Matters

The project alternatives proposed are aiming cost effective, operationally efficient, and functionally sufficient sewerage system establishment, which finally would cover 100 percent households in the cities. However, the following matters should be considered;

ⅰ) MWSS and MWSI are now rushing up to develop sewerage and sanitation services in their jurisdiction areas within rather short period. At this moment, total 11 sewage treatment plants and 4 communal plants in San Juan district are under bidding or under construction, and feasibility studies are undergoing to introduce sewerage treatment systems into 7 cities in Metro Manila including JICA project. These urgent implementation programs should be reflected by financial and budgetary consideration. MWSS envisages 100% service coverage with separate sewer collection systems by finishing concessionaires' agreements, year 2036, and this conversion from combined sewer collection systems will require additional huge expenses.

ⅱ) Most sewerage treatment system plans adopt combined sewer collection system, because of low capital investment cost and fast completion of construction, that is, fast commencement of the services. Because conversion manholes will be installed near the outfalls by the way that basically one outfall shall be connected to one conversion manhole, thus once the conversion manhole is connected to respective outfall, the areas, where wastewater discharging to the drainage line is generated, are automatically connected to the sewerage treatment systems. This means that any connection work to connect house holds' drain pipe to the sewer lines is not required.

The service charge shall be levied on the all residents in the area, but the service charge payment exception could not be applied to any individual household; therefore it is difficult to charge the sewerage tariff to the households without water supply connection or the residents who cannot be affordable payers or are not willing to pay.

17.1.2 Operation of Sewerage Treatment Service Works

The rapid development of the sewerage treatment systems also requires sufficient areas for the sewage treatment plants. And more operation and maintenance technicians will be necessary to cater for keeping good performances of the services. Before completion of sewerage treatment system construction, the septage treatment service would support to develop the environmental improvement as a transitional measure. Thus the following consideration shall be made.

ⅰ) The land procurement for sewage treatment plants will need the business negotiations to procurement with land owners. In case that the negotiation is failed, the project implementation plans shall be modified or partially re-planned. It requires MWSS and Maynilad the choices to modify their service development plans including the project implementation period, to re-design the system alternative, or to invest more cost than the original budget to procure the prospective land areas.

ⅱ) The sewage sludge treatment process will be constructed together with sewage treatment process. Maynilad has the implementation plan of septage treatment plants for sanitation services as a transitional measure before the sewerage treatment services completed or to cover the areas not in the plan by sanitation services. Therefore MWSI should develop to harmonize the septage treatment plants implementation plan with progress of the sewage treatment plants construction program, because septage treatment system would require some modifications to accept sewage sludge.

ⅲ) As the conversion manholes will be connected to the respective outfalls, areas where wastewater discharged to the drainage line are automatically connected to the sewerage treatment system.

ⅳ) Central Supervisory and Data Acquisition Systems by using Web recommended in the MWSI Master Plan (year 2008) should better be introduced as earlier as possible. The system would comprehensively support effective and efficient operations of current and future constructed many sewage treatment plants with the ancillary facilities, which would also devote to moderating the festinate require of staff incrimination. The system will also secure monitoring of unattended facilities like manhole pumping stations or monitor base operation plants like Tondo lift-up stations.

17.1.3 Technical Matters

After completion of agreement to the financing by JICA together with the final construction implementation plan during the loan negotiation between JICA and Philippine Gogernmnet, the following items should be reviewed and conducted at the design stage when the engineering consultant (s) is recruited.

ⅰ) In Metro Manila, outside personnel would never be allowed to enter in the sewerage treatment plant candidate sites until completion of contract for the land procurement transaction, thus topographical and geographical investigations of the site should be executed at the project design stage. Site area sizes were predicted by relative maps and the Google earth service or the latest contour map provided by MWSI during the preparatory surveys. Therefore measurements and soil analysis of STP sites shall be done when MWSI has procured them. The cost estimate of civil works are tentatively made with figures prevailingly used here in Metro Manila (refer attachment 17-1).

ⅱ) The interceptors are planned to install near the river or creek sides, however there are many congested areas in the project target places, any realistic diversion from the original plan should be studied at the design stage. That is, if there is an area where the isolation from the sub-basin central STP seems to be more economical and efficient, localized small plant or modular type plant which would be installed under the community basketball court shall be considered. In that case, the separation sewer system might be preferable, because generally to say, such area is also of poor street drainage systems and with very narrow communal road like Silverio Compound in Parañaque.

ⅲ) The STP alternatives are proposed with emergency power generator set. The capacity of the set is planned to cater for the least emergency power loads like communication facilities, emergency lights, exhaust or intake fans, emergency shutdown gates, minimum aeration for sewage bacteria support, plug outlets, odor control unit (if any) and miscellaneous small power supply. Small facilities like manhole pump stations will prepare connectors to connect removable gen-set that MWSI keeps. However, any special reason like the residents living near the STP caring for domestic invalid(s) and they are not likely to accept a permanent gen-set in the STP; the connection terminal system shall be considered.

ⅳ) Tidal stream may affect conversion manholes installed at respective outfalls, in case that the outfalls gone underwater at the high tide of Manila Bay, the diversion manhole pumps shall be installed instead of the conversion manholes, however, if it seems difficult to install, Installation of conversion manhole at upstream of the drainage and the downstream area from the point would require to install a new drainage pipe to the conversion manhole.

17.2 Conclusions and Recommendations

1) Need for sanitation and sewerage improvement

The need for sewerage in the Project target area is highlighted by the projections of pollution load from sewage generated in the Project area. The pollutant load is projected in Year 2036 at 62.7 t/d, which is 1.28 times higher than the value in 2007. With the implementation and operation of sewerage, the pollution load is projected to decrease to 5.6 t/d by 2036.

2) Surveys and Alternative Planning and Design

Based on maps and extensive field inspections, the drainage sub-basins of the Project area were delineated and the alternative sites of treatment facilities were identified and evaluated. The analysis of a range of applicable sewage treatment technologies resulted in the selection of Sequencing Batch Reactor (SBR) and Oxidation Ditch (OD) as the technology most suitable for the Project considering the space constraint, costs and manageability.

The extensive site analysis for the Project target area delineated 6 major sub-basins with areas area ranging from 249 to 2,979 ha. There are 36 sub-sub-basins in the largest sub-basin with area ranging from 15 to 416 ha. These sub-basins were further subdivided into smaller basins. The wastewater flow rates calculated from these sub-basins range from 14,170 to 250,852 m^3/d. On the basis of flow rate, available space and costs, the appropriate treatment process was designed for each site.

Some eight (8) alternative options or cases were developed for the sewerage system of the Project area. These cases were subjected to a selection criteria matrix and Case 8 was considered the most viable option.

The recommended project is planned for a four-phase implementation (detailed design, procurement, construction and operation) in the period 2013 to 2036. Construction duration of the various facilities is presented.

3) Financial and Economic Analysis

Investing on sanitation and sewerage projects is not generally financially-attractive. But the fact that it is a basic service, it will significantly impact on the socio-economic conditions of the target populace in terms of health (i.e. reduction in morbidity and mortality cases), access to safe water and on some economic activities like tourism.

The recommended Option (8) has a FIRR of 4.88% which is not viable when based on the MWSS APR of 9.3 percent and computed weighted average costs of capital or WACC of 6.08 percent. Recovery of investment can be sourced by MWSI from its other financial activities like revenues from short term investments. As long as the high collection efficiency rate of 97 percent is maintained by the MWSI, possibility of cost recovery for the project will be achieved.

In terms of economic viability, the said Option is economically feasible. Based on the sensitivity/risk analysis conducted, it can remain economically feasible up to a combination of 30 percent increase in project costs and 25 percent decrease in project benefits.

On one hand, an updated WTP should be conducted in the target cities to determine the degree of willingness and the affordability to pay of the residents and commercial establishments in said areas.

4) Environmental Assessment

All proposed project options will impact the environment positively, most notably the water bodies surrounding Parañaque and Las Piñas. The main purpose of the Project, regardless where its components are built and operated, will reduce the amount of pollutants that degrade the water quality of the creeks, rivers, and portions of Manila Bay. The Project, once fully-established, shall improve the poor state of the waterways of Parañaque and Las Piñas. This in turn could result reduction of environmental and public health costs, thus improving the local economies of the community. The proposed Project's positive impacts on the environment outweigh the negative impacts.

The following is a summary assessment for Option 8 (the recommended option):

- The project areas are situated in a suitable geological and soil condition.
- The sites, on which the 11 installations will be constructed, are primarily built-up areas. This means that the ambient air and noise quality, and flora and fauna conditions in the area were already negatively affected prior to the Project. However, it is still the primary responsibility of MWSI to ensure that all safety practices are implemented to prevent further degradation of the surrounding environment.
- There are no indigenous people or illegal settlers that would be directly affected since most of the proposed sites are vacant lots.

- Five (5) out of 11 installations (STPs and PS) will be located in residential zones, as such special permits, clearances, and/or endorsements from the LGU and community organizations must be obtained.
- Nine (9) bodies of water were identified near the project impact zone, which could be affected positively or negatively, depending on the performance STP.
- STP No. 5 (ID No. P-6) is located near Manila Bay, which could be directly subjected to high winds and waves during typhoons.

5) Social and Institutional Assessment

The social and institutional assessment established the social safeguards that need to be addressed, particularly involuntary resettlement and compensation, before the project initiates any development activity concerning civil works, construction and other operation works. The assessment also addressed the land acquisition and resettlement on the affected areas of the Project, particularly, the informal settlers.

6) Regulatory Review

The important rules and regulations governing sewerage and sanitation undertakings in the Philippines which may be applicable to the proposed sewerage project were reviewed and the relevant sections were summarized. It also enumerated pertinent provisions of recently passed laws and administrative orders that may have impacts on the development and implementation of existing and future sanitation and sewerage projects of MWSI.

Reviews on the Clean Water Act and the *mandamus* issued by the Supreme Court of the Philippines on the Manila Bay cleanup were discussed in relation to the possible impacts on the on-going and future undertakings of MWSI. The MWSS Concession Agreement (CA) with MWSI, which in April 2010 was extended up to 2037, was also reviewed focusing on the revised targets that must be complied by MWSI in terms of sanitation and sewerage coverage.

7) Next Steps to be Taken

Next steps to be taken by JMWSS/MWSI and JICA are recommended as follows.

(1) Decision of Funding Scheme (by end of July 2011)
(2) Land acquisition (by end of 2011)
(3) Resettlement Action Plan (RAP) for Land acquisition (simple version) (by June/July 2011)
(4) Stakeholders meetings (by June/July 2011)
(5) Loan scheme for the Project (by June 2011)
(6) Measures to include the Poor (i.e. OBA) (by July 2012)
(7) Secure the necessary government clearances and permits (i.e. ECC, building permit, discharge permit, etc.) (by March 2012)
(8) Financial Scheme (by August 2011)
(9) Project implementation and management structure to assure keeping initial target completion schedules of the sewerage and sanitation projects running in parallel. (by End of 2011)
(10) Rapid and proper land acquisition for the plant sites.(by End of 2011)

Attachment 17-1

DESIGN CRITERIA

LOADING

Live Load	10.0 KPa
Surcharge at adjacent side	10.0 KPa
Impact Load	15% of Live Load
Dead Load	
Weight of Concrete	23.60 KN/m^3
Weight of Steel	77.10 KN/m^3
Weight of Fresh Water	9.81 KN/m^3
Weight of Waste Water	10.20 KN/m^3
Weight of Soil	17.00 KN/m^3

MATERIAL PROPERTY

Concrete	
Compressive Strength (fc')	27 MPa / 4000 psi
Modulus of Elasticity (Ec)	4700 $(fc')^{1/2}$ MPa
Reinforcing Steel	
Yield Strength (fy)	
20mm dia. and greater	414 MPa / Gr.60
16mm dia. and 12mm dia.	275 MPa / Gr.40
12mm dia. and smaller	227 MPa / Gr.33
Modulus of Elasticity (Es)	200,000 MPa
Soil	
Internal angle of friction	30 degrees
Ka / Kp	0.333 / 3.000
Bearing Capacity	144 KPa / 3000 psf (for site verification)

REFERENCES

National Structural Code of the Phils. - *Building - 5th Edition*
Technical Data and Specifications - *A.B. Carillo*
Reinforced Concrete Design - *Jack McCormac*
Reinforced Concrete Fundamentals - *P.M. Ferguson, J.E. Breen, J.O. Jirsa*
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