THE SOCIALIST REPUBLIC OF VIET NAM
DONG NAI PEOPLE’S COMMITTEE

THE SOCIALIST REPUBLIC OF VIET NAM PREPARATORY STUDY PHASE II FOR DONG NAI WATER ENVIRONMENT IMPROVEMENT PROJECT (Sewerage and Drainage Sector)

FINAL REPORT

MAY 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

NIHON SUIDO CONSULTANTS CO., LTD.
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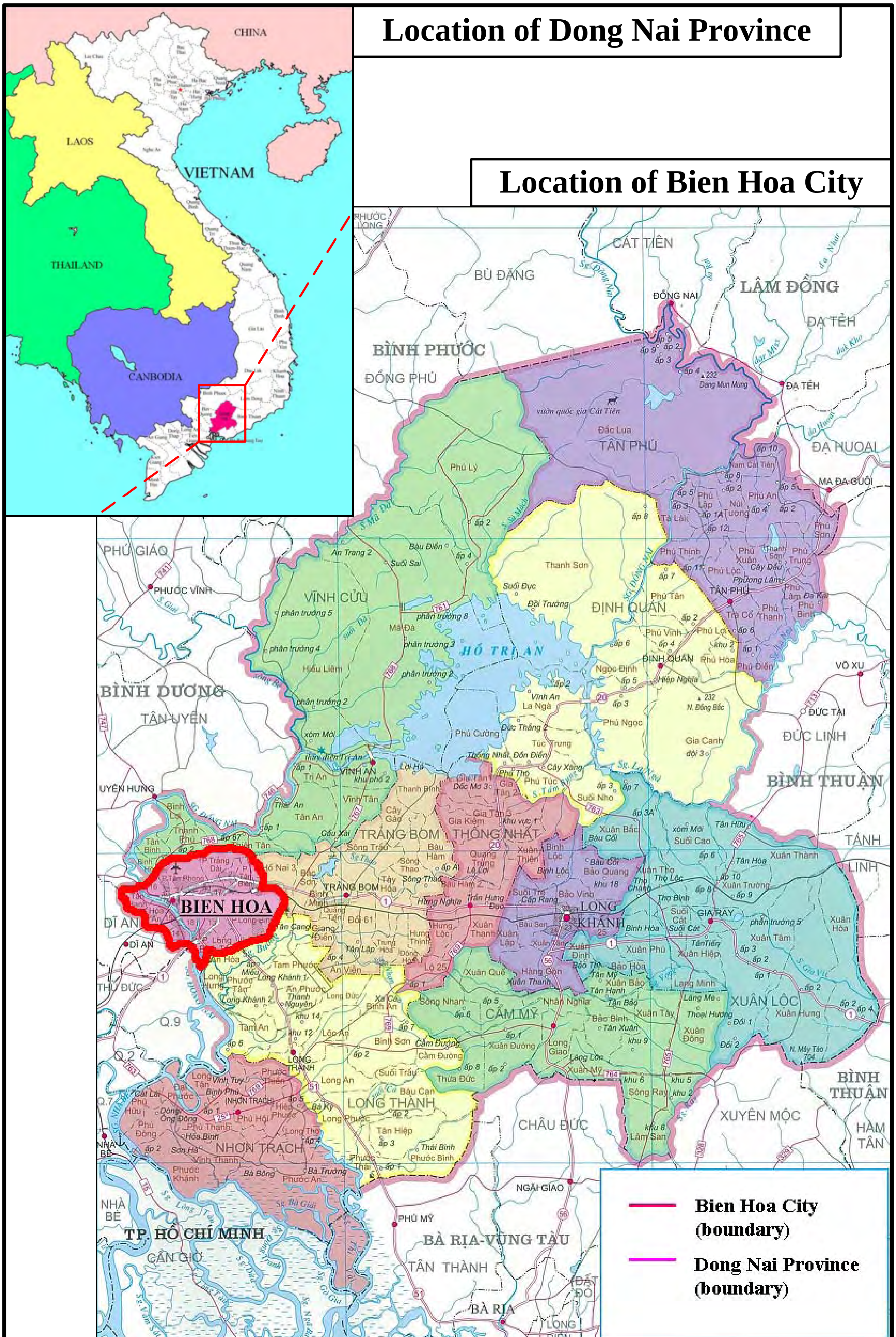
CURRENCY RATES (effective as of February 2011)

1 VND	=	0.00436	¥
1 US$	=	18,945	VND
1 US$	=	82.6	¥



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PREPARATORY STUDY PHASE II FOR DONG NAI WATER ENVIRONMENT IMPROVEMENT PROJECT
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LISTS OF ABBREVIATED & TECHNICAL WORDS

ADB	Asian Development Bank
BLT	Build, Lease, and Transfer
BLOT	Build, Lease, Operate, and Transfer
BOD_5	Biochemical Oxygen Demand
BOO	Build, Operate, and Own
BOOT	Build, Operate, Own, and Transfer
BOT	Build, Operate, Transfer
BROT	Build, Rehabilitate, Operate, and Transfer
BTO	Build, Transfer, and Operate
CAS	Conventional Activated Sludge
CDM	Clean Development Mechanism
CLD	Center for Land Development
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
CPC	City People’s Committee
CSRP	Compensation, Support and Resettlement Plan
CSRC	Compensation, Support and Resettlement Committee
C/B	Capacity Building
DARA	Department of Agriculture and Rural Department
DI	Ductile Cast Iron
DNPPC	Dong Nai Province People’s Committee
DNWSCC	Dong Nai Water Supply Construction Company
DO	Dissolved Oxygen
DOET	Department of Education and Training
DOF	Department of Finance
DOH	Department of Health
DOLISA	Department of Labor, Invalids and Social Affairs
DONRE	Department of Natural Resource and Environment
DP	Displaced Persons
DPI	Department of Planning and Investment
D/D	Detailed Design
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EL.	Elevation
EMP	Environmental Management Plan
EPA	Environment Protection Agency
EPF	Environmental Protection Fee
FGD	Focus Group Discussion

FIRR	Financial Internal Rate of Return
F/S	Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I up to the year 2010 (F/S Report)
GDP	Gross Domestic Demand
GHG	Green House Gas
GIS	Geographic Information System
GPS	Global Positioning System
GTZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
GOV	Government of Viet Nam
H_2S	Hydrogen Sulfide
HCAU	House Connection Administrative Unit
HCMC	Ho Chi Minh City
HDPE	High-Density Polyethylene
HHs	Households
ICB	International Competitive Bidding
IEC	Information Education and Communication
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
JFC	Japan Finance Corporation
JICA	Japan International Cooperation Agency
KAP	Knowledge, attitude and practices
LCB	Local Competitive Bidding
LEP	Law on Protection of the Environment
LQ	Living Quarter
LURC	Land Use Right Certificate
MARD	Ministry of Agriculture and Rural Development
METI	Ministry of Economy, Trade and Industry (Japan)
MOC	Ministry of Construction
MOF	Ministry of Finance
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Plan and Investment
MPN	Most Probable Number
MTP	Manhole Type Pump Station
M&E	Mechanical and Electrical
NGO	Non Governmental Organization
ODA	Official Development Assistance
O&M	Operation and Maintenance
PAP	Project Affected Person
PC	People’s Committee
PCO	Public Communications Officer
PMU	Dong Nai Management Unit for sewerage Projects (Project Management Unit)

PPC	Provincial People's Committee
PPI	Private Public Initiative
PPP	Public Private Partnership
PRU	Public Relations Unit
PS	Pumping Station
PSC	Project Steering Committee
PVC	Polyvinyl Chloride
RAP	Resettlement Action Plan
RC	Reinforced Concrete
RF	Revolving Fund
RLF	Revolving Loan Fund
RLT	Rehabilitate, Lease, and Transfer
ROT	Rehabilitate, Operate, and Transfer
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control and Data Acquisition
SDCO	Sewerage and Drainage Company
SPC	Special Purpose Company
SS	Suspended Solid
STP	Sewage Treatment Plant
SV	Construction Supervision
T-N	Total Nitrogen
T-P	Total Phosphorus
THMs	Trihalomethanes
TOR	Terms of Reference
TV	Television
UASB	Upflow Anaerobic Sludge Blanket
UDC	Urban Drainage Company
URENCO	Urban Environment Company
USD	United States of American Dollar
UV	Ultraviolet
VAT	Value Added Tax
VFD	Variable Frequency Drives
VND	Vietnamese Dong
WB	World Bank
WTP	Willingness-to-pay
WWTP	Wastewater Treatment Plant

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EXECUTIVE SUMMARY

1. Background

Bien Hoa City in Dong Nai Province, Ho Chi Minh City, and Vung Tau City in Ba Ria Vung Tau Province are developing into strategic economic zones in the southeastern region of Viet Nam. Dong Nai Province attracted foreign investment amounting to USD 12,824 million in 2007, the third highest in the country, following Ho Chi Minh City and Hanoi City. In terms of investment from Japanese enterprises, Dong Nai province ranks first in Viet Nam.

In the midst of the economic advancements, sewage collection and drainage systems are not well developed compared with other urban infrastructure taking place in Bien Hoa City. Only 40% of the city has sewage collection and drainage facilities or has made plans for them. There is no sewage treatment plant in the city. Untreated sewage is discharged directly to open channels that drain to the Dong Nai River, which is also a water source for Ho Chi Minh City's domestic water supply system. The effect on the water environment is serious and the development of infrastructure for sewerage is an urgent issue for Bien Hoa City.

Localized flooding frequently occurs when there is heavy rainfall. The problem in some areas is aggravated by the influence of high tides on river water levels. Flooding damages properties resulting in economic losses. Flooding also affects the flow of traffic. Flood water is a mix of raw sewage and urban runoff that is very unsanitary and presents a risk to public health. Poor drainage can also lead to problems with odor, mosquitoes and fly breading which can have an impact on public health.

The accumulation of garbage and sediment in surface drains greatly reduces flow capacity. In other cases development has encroached on drains reducing the cross section. Continued urbanization will result in more impervious surfaces creating even more surface water thereby increasing the size and frequency of floods. There is therefore an urgent need to improve drainage in Bien Hoa City to mitigate future flood damages, improve living conditions and reduce the risk to public health.

Recognizing the importance of improving the water environment and the general wellbeing of its residents, the Dong Nai Province People's Committee (DNPPC) prepared master plans for water supply and sewerage/drainage for both urban and industrial development areas (target year 2020). In 2008 they subsequently executed a feasibility study (F/S) for key infrastructure components identified in the master plans. Based on the F/S, DNPPC requested a Japanese Yen Loan from JICA to implement the Dong Nai Water Improvement Project comprising the development of sewerage/drainage facilities in Bien Hoa City and Phase II of the Nhon Trach Water Supply Project.

In response to the request for funding JICA sent a preparatory study team to work on the Dong Nai Water Environment Improvement Project (hereafter called the Phase I Study) from February and May 2010. The team reviewed DNPPC's master plans and F/S, collected and analyzed basic data to determine the necessity of the project, and examined the feasibility of implementing various priority projects in different groupings.

In the Phase I Study, the necessity of sewerage and drainage projects in F/S area (about 3,635 ha) was confirmed, and project components appropriate for Japanese Official Development Assistance （ODA） were proposed. Sewerage projects are needed because the canals in Bien Hoa City have almost the same water quality as raw sewage, incidences of waterborne diseases are reported every year, and there is no centralized sewerage treatment system. Drainage projects are also a necessity because of the inundation experienced in the area and the lack of maintenance of canals. The F/S area was divided into three priority areas for implementing sewerage systems, according to pollutant load generated, population and water consumption per capita. Sewerage in the Central area (about 1,072 ha or 971 ha measured excluding water surface and large park areas) is a high priority project because of the significant pollutant load generated by wastewater, the large served population and existing high water consumption per capita. As for drainage systems, four of the eight major drains (San Mau, Linh Bayou, Bien Hung, and Dien Hong) where flooding has been confirmed are the priorities.

In preparation for funding by Japanese ODA Loan, JICA dispatched the present Study Team in November 2010 to prepare the project implementation plan for the priority projects identified in the Phase I Study. The current preparatory mission is referred to as the Phase II Study.

2. Objective of the Study

The purpose of the Phase II study is to formulate the project implementation plan for Japanese ODA Loan, based on the project components proposed in the Phase I Study.

3. Service Area

The Priority Area for sewerage development and the list of canals to be improved were identified in the Preparatory Study for Dong Nai Water Environmental Improvement Project in June, 2010 (Phase I Study conducted by JICA). Sewerage is planned for the entire urban area designated in the Adjusted General Plan less areas that do not contribute any sewage such as large parks, water surfaces, and cemeteries. This area, referred to as the Entire Service Area, is 6,174 ha. The Priority Area for the implementation of sewerage was selected within the F/S area based on the population density, pollution production level, implementation possibility etc. in the previous JICA preparatory study I. The Priority Area is 971 ha. The entire sewerage/drainage service and Priority Areas are shown in Figure S-1.

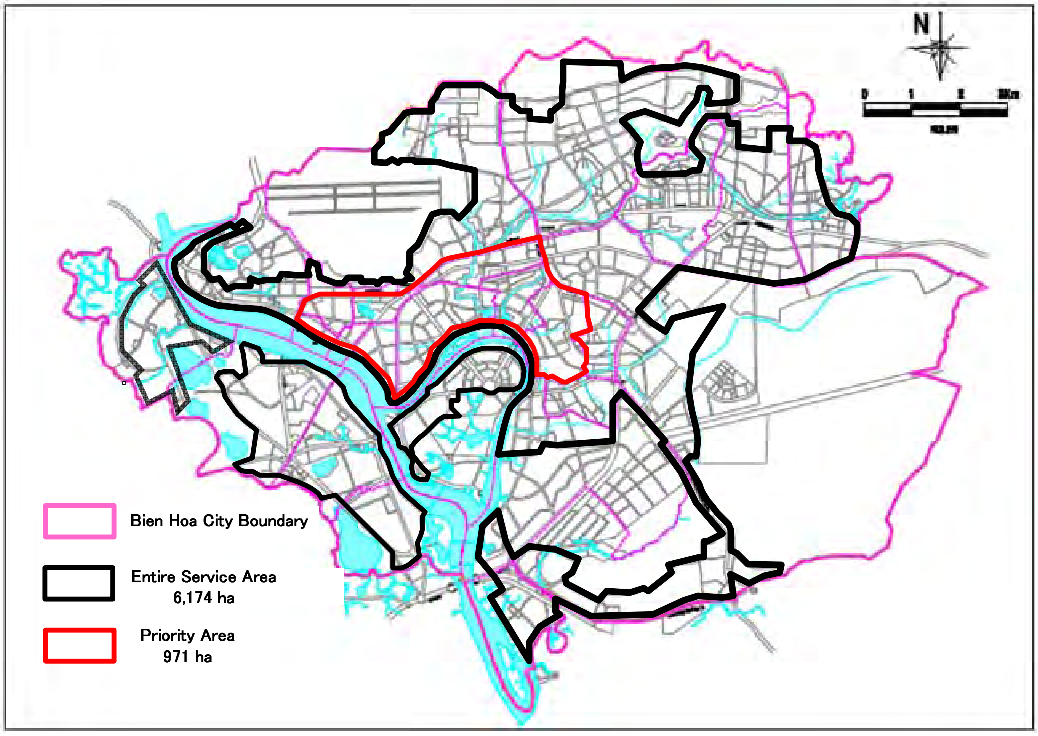


Figure S-1 Sewerage and Drainage Service Areas

4. Proposed Scope of the Project

Based on the needs identified in the Priority Area, it is recommended a project with the following main components:

- Construction of interceptor sewers and additional combined sewer in combined sewer area
- Construction of sanitary sewers and storm sewers in separated sewer area
- Construction of Intermediate pumping stations
- Construction of STP
- Improvement of canals

Table S-1 presents project components in the Priority Area (Scope of the Priority Project I). Almost all the components were identified in the Phase I Study. The JICA Study Team has added bank protection works for Linh Stream to the scope of work because Linh stream is the discharging body of the proposed STP 2 and must function reliably as the outlet from the STP.

Table S-1 Proposed Project Components

Components	Unit	Quantity	Remarks
STP2	m^3/d	52,000	Tam Hiep Ward
Pumping Station	places	2	Thong Nhat Ward, STP2 Site
Manhole Type Pump Station	places	25	
Sewerage Facilities			

Components	Unit	Quantity	Remarks
Main Trunk Sewer	km	12	D 200mm – 1500 mm
Branch Sewer	km	42	D 200mm – 280 mm
Tertiary Sewer	km	203	D 200mm
Interceptor pipe	km	6	D 100mm – 900 mm
Drainage Facilities			
Main Storm Sewer for Separate Area	km	45	D 600mm – 2000 mm, B 3000mm × H 3000mm
Main Storm Sewer for Combined Area	km	10	D 600mm – 2000 mm, B 2000mm × H 2000mm
Branch Storm Sewer	km	111	D 500mm
Canal Improvement			
2.1 Bien Hung ditch with Gate	m	2,160	
3.2 Dien Hong ditch	m	370	
4.1 San Mau stream	m	3,650	
4.2 San Mau stream	m	2,480	
4.3 San Mau stream	m	390	
4.4 San Mau stream	m	610	
4.5 San Mau stream	m	1,310	
4.6 San Mau stream	m	720	
5.1 Linh Bayou	m	1,060	
6.1 Linh Bayou	m	1,150	
Linh Stream	m	1,150	
Procurement of O&M equipment	LS	1	High-Velocity Jet Truck, Vacuum Truck etc.

D: Diameter, B: Width, H: Height

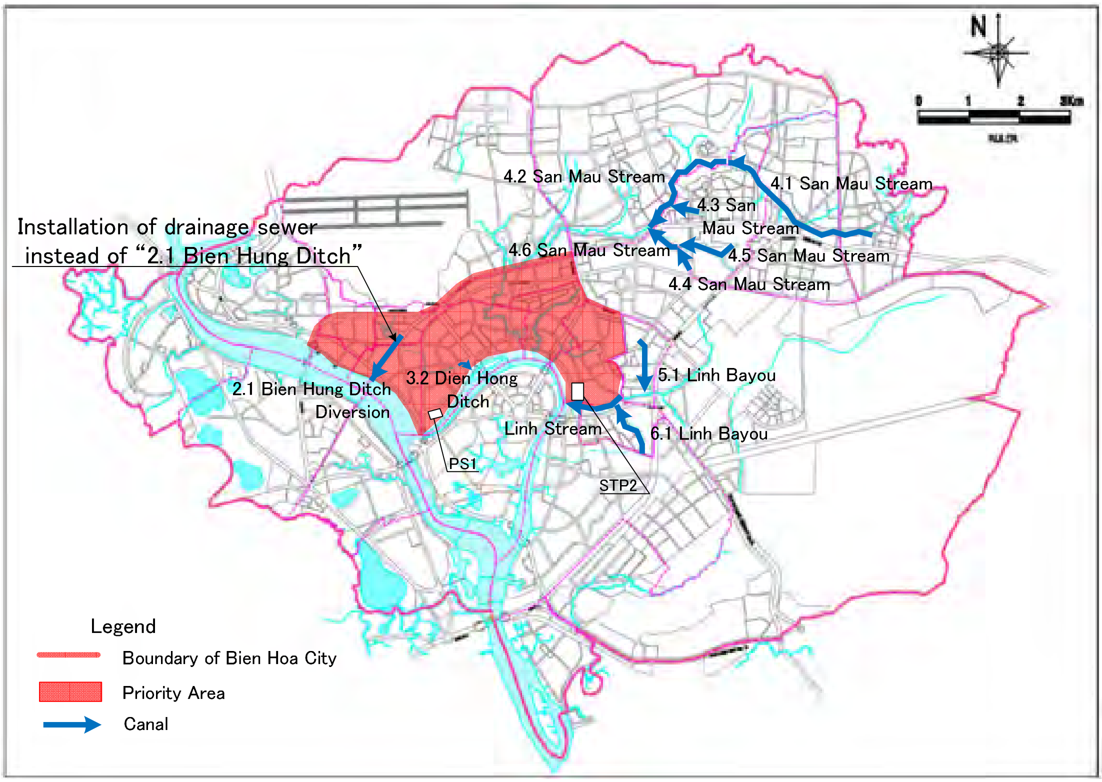


Figure S-2 Scope of Works
(Priority Area for Sewerage and Drainage Development and Canals to be Improved)

JICA Study Team has recommended a Conventional Activated Sludge (CAS) process for sewage treatment method. However, PMU is interested in the Sequencing Batch Reactor (SBR) process, as the construction costs of CAS and SBR are almost same. The Sewage treatment method is finally decided by Vietnamese side in later stages. An outline of the STP is presented in Table S - 2 and main facilities for the CSA process are summarized in Table S-3.

Table S-2 Outline of STP

Location	Tam Hiep Ward
Area	9.34 ha
Present Land use	Mainly fish culture pond
Capacity	52,000 m^3/day (Priority Project I)
Wastewater Treatment Method	Conventional Activated Sludge (CAS)
Sludge Treatment Method	Gravity Thickener + Mechanical Dewatering
Inflow Water Quality	BOD_5 200mg/L, SS 250mg/L
Treated Water Quality	BOD 30mg/L, SS 30mg/L
Discharge	Linh Stream

Table S-3 Main Facilities and Unit Processes for CAS at STP2

ID	Facility	Unit Process	Q'ty
(1)	Main Pumping Station (including Grit Chamber)	Screening, grit removal and pumping	1
(2)	Distribution Tank	Flow rate control for each sedimentation tank	1
(3)	Primary Sedimentation Tank	Settling of biomass	4(16)*
(4)	Reactor Tank	Aeration and mixing for conversion to biomass	4(8)*
(5)	Final Sedimentation Tank	Settling of biomass	4(16)*
(6)	Disinfection Tank	Removal of pathogens by ultraviolet radiation	1
(7)	Blower Room	Generation of air for reactor tank	1
(8)	Gravity Thickener	Reducing sludge volume by gravity	4
(9)	Sludge Pump Room	Transfer concentrated sludge to Sludge treatment building	1
(10)	Sludge Treatment Building	Mechanical Sludge Dewatering Unit, Sludge Storage Tank, Electric Power Generator Unit, Odor control Unit	1
(11)	Administration Building	Offices, process laboratory, electrical room, controls	1
(12)	Workshop	Repair equipment, storage	1
(13)	Garage	Parking space for maintenance vehicles	1

*4(16): 4 process Streams with 16tanks

5. Institutional Arrangements for Project Implementation

The Project Management Unit (PMU) would implement the design and construction of the project. A state owned enterprise Dong Nai Sewerage and Drainage Company (SDCO) would be established to manage the operation and maintenance of the project. SDCO would initially focus mainly on sewage management but would also maintain storm water sewers in the project service area and the canals improved by the project. URENCO, one of the existing urban infrastructure management companies, would continue to maintain storm water drains and canals in areas outside the project service area.

To operate and maintain sewerage and drainage services, the operator must have proper facilities as well as an up to date inventory of the system and equipments. It must also have a vigilant preventive maintenance program and regularly assess if the existing infrastructure is keeping up with changing conditions and demand. Personnel must be well trained to identify and deal with operational problems. It is recommended that daily operations and maintenance activities be carried out by 2 divisions - the Network Management Division and the Wastewater Treatment Division, which would be supported by the technical services, finance, administration and customer relations functions. (Refer to Figure S-3)

Every year, about 20% of the sewage collection network should be systematically cleaned and inspected by CCTV camera. Repairs to sewers and manholes would be needed on an annual basis. Maintenance of storm water collection networks would include replacing broken lids on concrete covered channels, repairing concrete channels damaged by vehicles, regularly scheduled inspection and cleaning of sewer pipes and channels, and inspection and cleaning of street inlet grates. Garbage and accumulated sediment have to be removed from ditches and streams regularly and especially before the rainy season. Rights-of-way along drains have to be maintained to prevent encroachment by illegal building activities. Maintenance of pumping stations would typically consist of daily monitoring of pump operations and responding to abnormal conditions, daily removal of screenings and grit from the inlet works, periodic removal of silt from the intake well, regular preventive maintenance of mechanical and electrical equipment, repairing of motors and pumps in case of emergency breakdowns, and occasional cleaning of the pressure main.

The staff estimate for the maintenance of the sewage and storm water collection network for a service population of 200,000, is 58, which includes 3 superintendants, and crews assigned to inspection, cleaning, minor and major repairs, as well as a supporting pool of general labor, equipment operators and TV inspection workers. Another crew of 20 would be required to maintain approximately 15 km of open channel drains and a crew of 9 for 25 manhole type pumping stations. Specialized equipment for maintenance of sewerage and storm water collection pipes and equipment for dredging and cleaning drains are also considered. A staff of 33 would be required to implement a maintenance program for septic tanks.

It is recommended that the treatment plant operate with one full shift 5 days a week and a reduced number of staff at night and on weekends (i.e. a one-plus shift plant). Sludge handling operations would be 6 days a week. The staff estimate for the treatment plant is 18 for process operations and maintenance, 13 for equipment maintenance, and 3 for laboratory operations for a total staff complement of 34 plus one manager.

Capacity building would include technical assistance at the pre-construction stage, executive management training for project steering committee and related personnel, and training for project implementation staff during the pre-construction stage. O&M staff would be provided class room training during construction and hands-on training during the commissioning period. Technical assistance on operating all the components of the infrastructure would also be given. Training would be delivered by international and Vietnamese experts in collaboration with local environmental technology institutes. The total estimated cost is US$3,204,808.

Household connections present the most challenging aspect of project implementation. A survey showed that most households are only willing to pay 114,600 VND per month over a 2 year repayment period to connect to the wastewater collection system. This is equivalent to a total cost of 2.75 million VND and is not sufficient to cover the estimated average cost of a sewer connection. Therefore most households would require substantial financial assistance either through a grant and/or a Revolving Loan Fund (RLF). Poor households could receive 100% subsidy in the form of a grant. Non-poor households could receive 70% subsidy in the form of a grant and repayable loan to cover the balance of the cost. The total amount of funding required for 28,700 house connections that would be constructed over 60 months from 2016 to 2020, would be 446,000 million VND or $US23.6 million, an average of US$820 per house connection. The RLF would be managed by the PMU and administered by the Women's Union. The Study team suggests that seed money can be allocated from the PPC budget or from proceeds of the JICA loan or both. The PMU would administer and monitor the household connection process. This includes setting the requirements for borrowers, setting loan terms, developing forms for the program, providing grants, loans and technical assistance to borrowers and tracking and monitoring existing loans.

The project would implement an IEC campaign early to stimulate positive community response. The study team proposes that a Public Relations Unit (PRU) be created in the PMU to manage and deliver the IEC campaign, assisted by an experienced international consultant.

The IEC campaign would provide detailed information about the project activities and their beneficial outcomes, educate people on water environment issues and the negative impacts of solid waste disposal to drains and gutters, and the need for their participation on wastewater management. As a result, people would be encouraged to make the connection to the sewer system. The campaign in 3 phases over 72 months, would start with the awareness and knowledge generating phase in the first 6 months; followed by the promotion of house connections and desired practices from years two to six during construction. Continuing education would be conducted at regular intervals during and post-construction. For the first phase of the sewerage project, the PRU would have 1 Public communications officer, 4 Sanitation Trainers, and 18 Motivators.

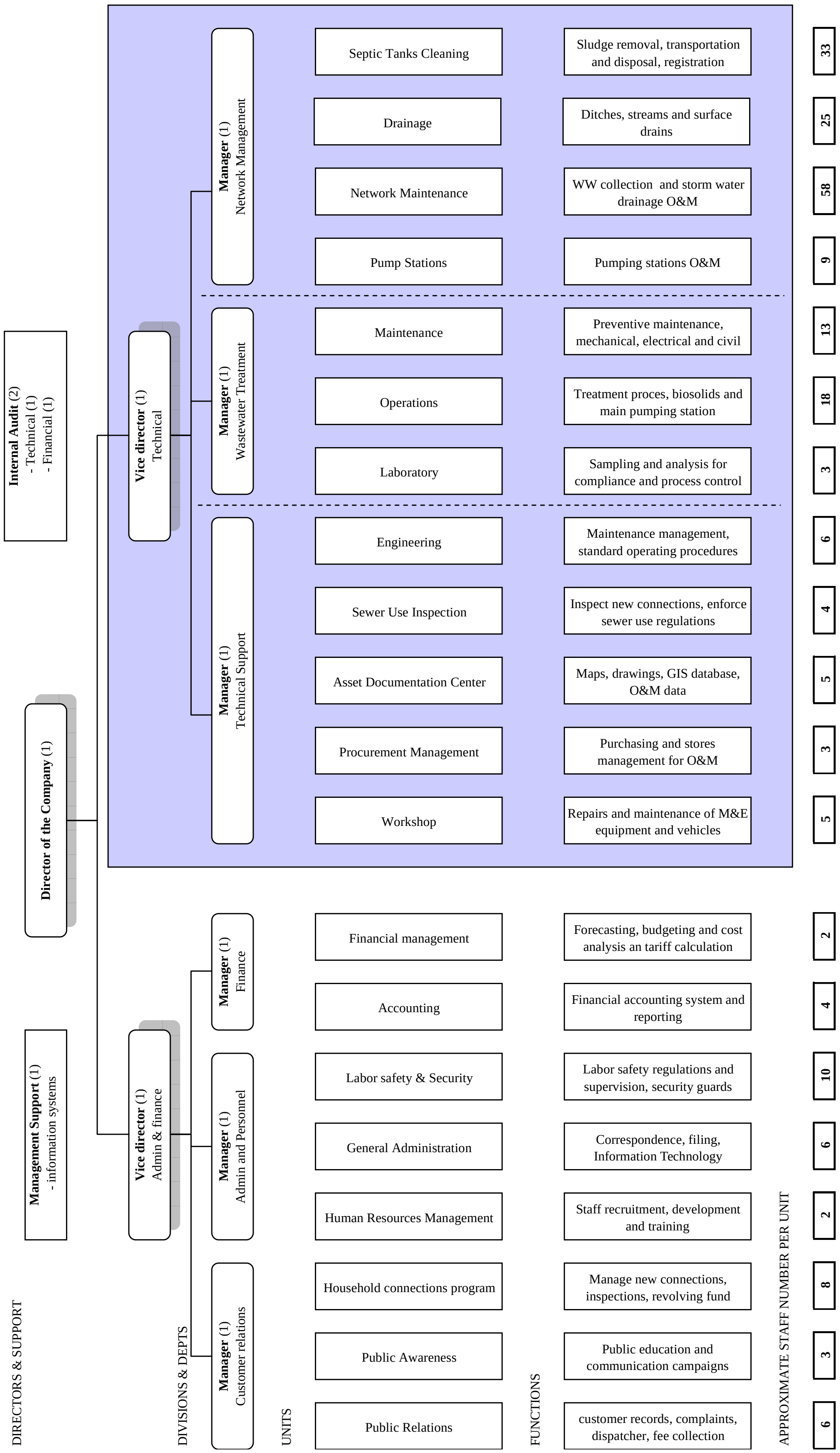


Figure S-3 Proposed Sewerage and Drainage Company Organizational Chart

6. Implementation Schedule

The JICA Study Team estimates that it will take nine (9) years to implement the project starting with consultants' selection up to the end of 1-year maintenance training after commissioning. Assuming the project starts after loan agreement in August, 2011, the main facilities would be commissioned by the middle of 2019. The project implementation schedule is presented in Figures S-4 and S-5.

Other sewerage projects must be implemented after Priority Project I to continue to improve the environment and sanitary conditions in the city. A study (F/S) is proposed near the end of the construction period to determine the feasibility and scope of a second project.

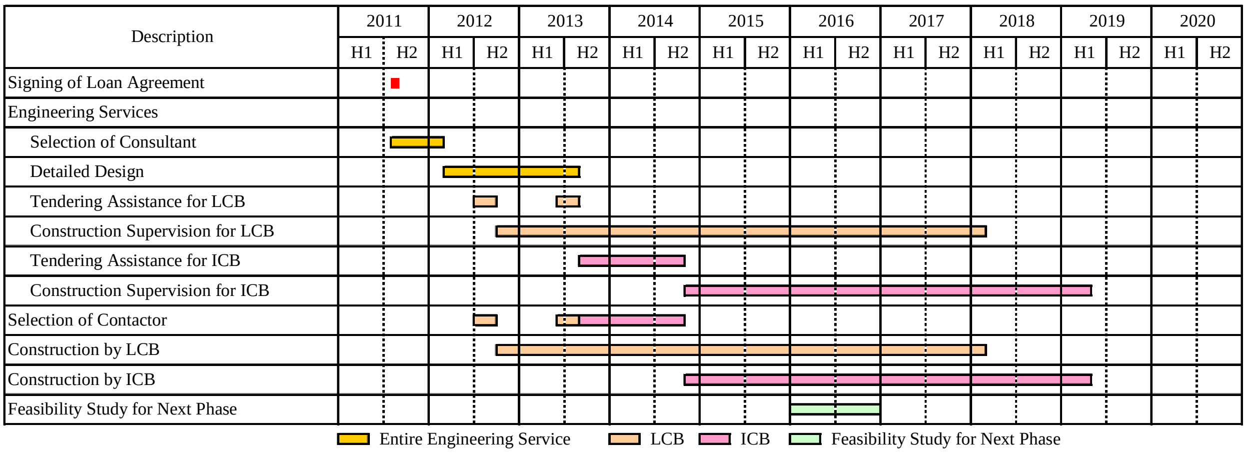


Figure S-4 Implementation Schedule for Construction

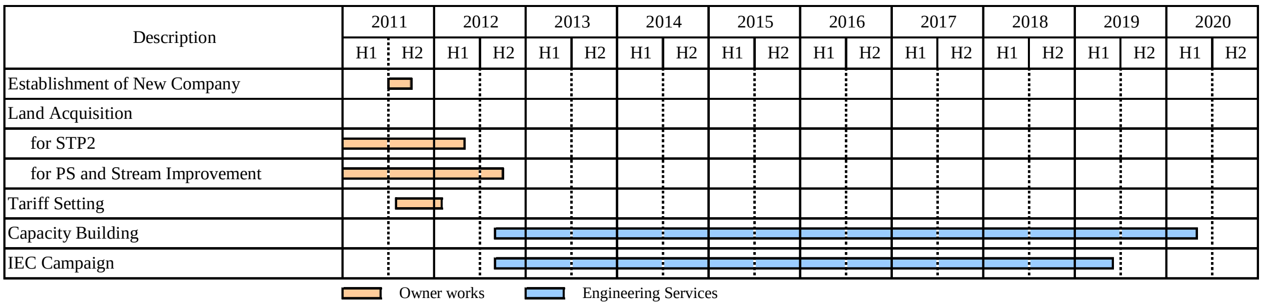


Figure S-5 Implementation Schedule for Preparatory Works

7. Cost Estimate

The JICA study team recommends that the contracts be grouped into packages as follows (actual packaging to be fixed in later stages):

- The site work for STP2 to start immediately after completion of the resettlement process would be under one contract. This package would be tendered by Local Competitive Bidding (LCB), since the construction can be carried out by a local contractor.

- The construction of the drainage and sewerage system (including the treatment plant and pump stations) would be under one contract to minimize excavation and disruption because the pipes are installed under the same road. This package would be tendered by International Competitive Bidding (ICB), since the construction would require advanced techniques, such as pipe jacking method, SCADA system and mechanical equipment for sewage and sludge treatment.

- Canal improvements would be under a separate contract because the work is quite independent of other project components. This package would be tendered by Local Competitive Bidding (LCB), since the work can be carried out by a local contractor.

- The purchase of maintenance equipment would be under another contract to be tendered by LCB, since local trading companies can import the equipment and take care of the required maintenance and repair of the equipment in Viet Nam.

The package groups of Priority Project I are shown as the Table S-4.

Table S-4 Package Groups and Bidding Methods for Priority Project I

Name of Package Group	Content	Bidding Method
PACKAGE Group: Site Work for STP2	Primary Site Work for STP2	LCB
PACKAGE Group : Sewerage and Drainage Facilities	Sewerage Facilities	ICB
	Drainage Facilities	
	2.1 Bien Hung Ditch Diversion	
	Pumping Station (PS1)	
	Pumping Station (PS5)	
	STP2	
PACKAGE Group: Canal Improvement	Canal Improvement	LCB
PACKAGE Group: Maintenance Equipment	Purchasing of Maintenance Equipment	LCB

The estimated base costs of construction and purchase of maintenance equipment are presented in Table S-5. Costs are at the February 2011 price level. The estimate is for all direct costs related to construction works based on a preliminary engineering design of the sewerage and drainage systems and canal improvements.

The unit rates for construction in the year 2010 promulgated in “MOC Decision No.295/QD-BXD dated 22/03/2011” was used for setting the costs of basic equipment, construction materials and works. The costs of particular items not included in the Decision were obtained from suppliers and contractors, or based on past experience in Viet Nam. The higher of the two values is selected.

Table S-5 Estimated Base Cost (February, 2011 price level)

Description	Cost		Total	Total
	Foreign	Local		
	Million yen	Million VND	Million yen	Million US$
PACKAGE Group: Site Work for STP2				
Primary Site Work for STP2	0	28,178	123	1.5
Total	0	28,178	123	1.5
PACKAGE Group : Sewerage and Drainage Facilities				
Construction Work				
Sewerage Facilities	2,903	1,282,255	8,494	102.8
Drainage Facilities	1,742	1,059,384	6,361	77.0
2.1 Bien Hung Ditch Diversion	1,245	27,839	1,367	16.5
Pumping Station-1	30	27,839	150	1.8
Pumping Station-5	45	39,863	219	2.7
STP2	594	545,382	2,972	36.0
Sub-Total	6,560	2,982,273	19,563	236.8
Equipment and Material				
Sewerage Facilities	267	0	267	3.2
2.1 Bien Hung Ditch Diversion	12	0	12	0.1
Pumping Station-1	187	0	187	2.3
Pumping Station-5	262	0	262	3.2
STP2	3,782	0	3,782	45.8
Sub-Total	4,511	0	4,511	54.6
Total	11,071	2,982,273	24,074	291.5
PACKAGE Group: Canal Improvement				
Canal Improvement	0	392,934	1,713	20.7
Total	0	392,934	1,713	20.7
PACKAGE Group: Management and Maintenance Equipment				
Management and Maintenance Equipment	0	167,078	728	8.8
Total	0	167,078	728	8.8
Ground Total of Construction Cost	11,071	3,570,463	26,638	322.5

The following exchange rates (effective as of February 2011) are used in the cost estimate:

Viet Nam Dong (VND) 1.0 = Japanese Yen (¥) 0.00436

US$ 1.0 = Japanese Yen (¥) 82.6 = VND 18,945

The estimated operation and maintenance costs are summarized in Table S-6 and costs for replacement of mechanical and electrical equipment and re-construction of structures are estimated as shown in Table S-7.

Table S-6 Operation and Maintenance Costs

Items		Cost (VND/year)
1. Personnel Cost		
	Management Personnel	1,097,791,200
	Administration and Finance Personnel	6,627,682,800
	Sewerage System O&M	13,954,258,800
	Storm Water Drainage O&M Personnel	3,155,328,000
	Septic Tank Cleaning Personnel	4,338,576,000
	Sub total 1	29,173,636,800
2. Electricity Cost		
	PS1	753,709,670
	STP2 (including PS5)	15,319,539,830
	Manhole Type Pump Stations	1,529,167,500
	Sub total 2	17,602,417,000

Items		Cost (VND/year)
3. Sludge Disposal and Chemical Cost		
	Sludge Disposal	3,036,800,000
	Polymer cost	148,394,400,000
	Activated carbon	4,600,000,000
	Lamp Replacement	275,000,000
	Sub total 3	156,306,200,000
4. Repairs & Maintenance Cost		
	Site Work for STP2	28,178,000
	Sewerage System (sewers, PSs, STP1)	18,547,323,299
	Drainage Facilities	1,458,990,110
	Canal	392,934,360
	Maintenance Equipment (for Sewerage Facilities)	1,805,299,729
	Maintenance Equipment (for Drainage Facilities)	1,307,286,011
	Maintenance Equipment (for Septic Tank)	1,899,755,760
	Sewer Cleaning Work: fuel (for Sanitary Sewers)	2,419,612,819
	Sewer Cleaning Work: fuel (for Drainage Sewers)	1,752,133,421
	Septage Collecting Work: fuel	1,648,121,000
	Sludge Disposal Work: fuel	369,672,000
	Standby Generator Maintenance Work: fuel	35,321,400
	Sub total 4	31,664,627,908
5. Establishment Cost		120,000,000
	Sub total 5	120,000,000
Total		203,809,031,708

Table S-7 Replacement and Re-construction Costs

Item		Cost (VND/year)
1. Site Work for STP2		563,560,000
2. Sewerage Facilities		
	Civil Structure and Building	60,557,938,176
	Equipment	68,975,228,400
3. Drainage Facilities		29,179,802,192
4. Canal		7,858,687,200
5. Maintenance Equipment for Sewerage Facilities		6,017,665,764
6. Maintenance Equipment for Drainage Facilities		4,357,620,036
7. Maintenance Equipment for Septic Tank		6,332,519,200
Total		183,843,020,968

Project costs including indirect costs and price escalation over the duration of the project are presented in Table S-8. Costs are based on the proposed construction schedule and annual disbursement of funds. Costs required for capacity building (C/B) for management, operation, and maintenance, IEC campaign are also included.

The administration costs for the PMU are taken as 3.0% of the eligible portion in accordance with Vietnamese practices of ODA loan.

The rate used in computing import tax is 10% of the expenditure in foreign currency of the eligible portion for construction materials.

Value added tax is taken as 10% of the eligible portion for construction and engineering services.

A price contingency is included in the cost estimate to cover the increase in costs of labor and materials over the duration of the project. The rates are applied in accordance with ODA loan in 2011 for Viet Nam as below.

Local currency portion: 10.5% of price escalation

Foreign currency portion: 1.8% of price escalation

Table S-8 Estimated Project Cost

Description		Foreign	Local	Total	Total
		Million yen	Million VND	Million yen	Million US$
A	Construction Contracts				
A.1	PACKAGE Group: Site Work for STP2	0	28,178	123	1.5
A.2	PACKAGE Group: Sewerage and Drainage Facilities	11,071	2,982,273	24,074	291.5
A.3	PACKAGE Group: Canal Improvement	0	392,934	1,713	20.7
A.4	PACKAGE Group: Management and Maintenance Equipment	0	167,078	728	8.8
	Sub-total	11,071	3,570,463	26,638	322.5
B	Contingencies				
B.1	Physical Contingency	617	312,240	1,978	23.9
B.2	Price Contingency on Construction Works	1,279	2,674,342	12,939	156.6
	Sub-total	1,896	2,986,582	14,917	180.5
C	Engineering Services				
C.1	D/D, CB, IEC campaign SV and Survey Works	1,510	260,306	2,645	32.0
C.2	Physical Contingency	82	19,974	169	2.0
C.3	Price Contingency on Engineering Services	121	139,183	728	8.8
	Sub-total	1,712	419,463	3,542	42.8
	Total (A+B+C)	14,680	6,976,508	45,097	545.8
D	Interest During Construction	1,565	0	1,565	18.9
	Eligible Potion	16,245	6,976,508	46,662	564.7
E	Land Acquisition				
E.1	Base Cost	0	404,316	1,763	21.3
E.2	Physical Contingency	0	138,956	606	7.3
E.3	Price Contingency on Construction Works	0	58,872	257	3.1
	Sub-total	0	602,144	2,626	31.7
F	Administration Cost	0	310,303	1,353	16.4
G	Vat				
G.1	Vat (1) for Construction	0	655,705	2,859	34.6
G.2	Vat (2) for Engineering Services	0	41,946	183	2.2
	Sub-total	0	697,651	3,042	36.8
H	Import tax	0	336,692	1,468	17.8
	Non Eligible Potion	0	1,946,790	8,489	102.7
Total Project Cost		16,245	8,923,298	55,151	667.4

8. FINANCIAL AND ECONOMIC ANALYSIS

8.1 Financial Analysis

8.1.1 Sewerage Tariff System

Currently an environmental protection fee of 10% is added to the water bill collected by the water supply company from every metered connection except for industrial zones. The fee is applied regardless of whether or not customers are connected to a sewer system. The water supply company deducts 7% for administration and transfers 93% of the fee to DNPPC. However, the environmental protection fee is not placed in a segregated fund nor is it transferred directly to URENCO or PMU in any way. URENCO and PMU greatly rely on funding allocated from

DNPPC and their revenue is in no way connected with the environmental protection fee's revenue stream.

In Viet Nam, according to government decree No.88/2007/ND-CP, "a sewerage tariff" separate from the environmental fee shall be charged to customers connected to sewerage systems based on the "polluter-pay" and "cost recovery" principles.

8.1.2 Financial Projection of Sewerage/Drainage Service

A financial projection is carried out to examine the feasibility of increasing the environmental protection fee or implementing a sewerage tariff to reduce the subsidy required from the government. Despite Decree No.88 stating polluter-pay and cost-recovery principles, PMU is of the opinion that the costs incurred from the project would be covered by increasing the environmental protection fee to all water consumers in Dong Nai Province. This practice has been common in other Vietnamese sewerage projects. The financial analysis also estimates newly established "sewerage tariff" to be charged only to the connected customers in the project area to cover only sewerage component O&M cost.

Taking the aforementioned into consideration, the financial analysis estimates the required tariff and subsidy levels for several cases presented in Table S-9. In all cases the debt service (repayment and interest payment of ODA loan) and the initial counterpart fund is subsidized. 2% of the median household income, or VND 120,000 per month, is applied as a threshold of ability-to-pay level in accordance with the regulations.

Table S-9 Case Scenarios

Case	Description	Depreciation Cost		
		A	B	C
		Not Included	Including Depreciation Cost for Equipment and Machines	Including Depreciation Cost for All Works
Case 1 **EPF Increase**	- Increase EPF to be collected from all DNWSCC customers (Domestic and Others. Industrial Zones excluded.) to cover O&M cost (direct & indirect) - Septage collection is excluded from EPF estimation - Depreciation cost and debt service are subsidized by government	**Case 1A** **Only O&M (Base Case)**	**Case 1B** **O&M + E&M Dep**	**Case 1C** **O&M + All Dep**
Case 2 **Sewerage Tariff According to Decree 88**	- Establish new "sewerage tariff" to be charged to connected customers to cover sewerage O&M cost - EPF is charged to All DNWSCC customers separately to cover the drainage O&M cost - Depreciation cost and debt service are subsidized by government	**Case 2A** **Only O&M**	-	-

(1) Results: Case 1 (Environmental Protection Fee for All DNPPC Customers)

Results for Case 1 scenarios (environmental protection fee increase) are presented in Table S-10. The project's O&M costs are equally distributed to all DNWSCC customers therefore the increase in fee is relatively small for each household. Even for Case 1C where all depreciation costs are included, the environmental protection fee in 2021 would be 72% which is equivalent to only 0.78% of the median household income (VND 6 million). The estimated fee percentage is inversely related to the actual amount of water consumed. For example a 40% reduction in the average amount consumed (i.e. 60 l/c/d for domestic) would result in a fee of 120% to provide the same amount of revenue.

Table S-10 Environmental Protection Fee Estimate (Case 1)

Case	Environmental Projection Fee Projection								Additional Subsidy Requirement
	EPF (% to Water Tariff)			EPF Rate (VND/Water Volume m^3)		Average Household Payment per Month		Household Payment vs Income	Annual Depreciation Cost (VND million per year)
	2019	2020	2021 -	Domestic	Other Services				
Case 1A (Base Case)	23%	36%	**39%**	1,694	5,648	DNP Urban Domestic Use (100 lcd)	25,416	**0.42%**	**177,511**
Case 1B (+ E&M Depreciation)	23%	51%	**54%**	2,329	7,765	DNP Urban Domestic Use (100 lcd)	34,941	**0.58%**	**98,160**
Case 1C (+ All Depreciation)	23%	69%	**72%**	3,115	10,383	DNP Urban Domestic Use (100 lcd)	46,724	**0.78%**	-

In addition to the proposed project, it is anticipated that other sewerage projects in Dong Nai Province will further increase the fiscal responsibility of the provincial government in the future. PMU is of the opinion that while it aims at gradual increase of the environmental protection fee keeping pace with the socio-economic development of the province, DNPPC will need to make budgetary appropriation to subsidize the sewerage and drainage service to fill in the financial gap.

(2) Results: Case 2 (Sewerage Tariff for Connected Customers)

Results for Case 2 (Sewerage tariff charged to connected customers) are presented in Table S-11. The sewerage service provider would need to charge a 334% surcharge on the water bill just to cover the costs of O&M. Asset depreciation costs of VND 136,114 million per annum would be subsidized. The surcharge would be equivalent to 5.94% of household income and would exceed the ability-to-pay level of 2%.

The sewer surcharge would have to be 112% to keep the average bill to 2% of household income (i.e. VND 4,848/m^3 in terms of tariff per water consumption volume). This lower tariff would require an additional subsidy of VND 100,677 million per annum to cover the balance of O&M costs.

Table S-11 Sewerage Tariff Estimate (Case 2)

Case	Sewerage Tariff Projection								Additional Subsidy Requirement			
	Sewerage Tariff (% to Water Tariff)			Wastewater Tariff Rate (VND/Water Consumption m^3)		Average Household Payment per Month (VND)		Household Payment vs Income	Subsidy to O&M Cost to Keep Tariff at 2% of Income (VND/m^3)	**Subsidy to O&M Cost (VND million/year)**	**Depreciation Cost (VND million/year)**	**Total Subsidy (VND million/year)**
	2019	2020	2021 -	Domestic	Other Services							
Case 2A (Only Sewerage O&M Cost)	185%	306%	334%	14,410	48,032	Project Area Domestic Use (165 lcd)	356,640	5.94%	8,892	**100,677**	**136,114**	**236,791**

Case	Environmental Protection Fee Projection							
	EPF (% to Water Tariff)			EPF Rate (VND/Water Consumption m^3)		Average Household Payment per Month (VND)		Household Payment vs Income
	2019	2020	2021 -	Domestic	Other Services			
Case 2A (EPF for Drainage O&M + All Dep.)	1.3%	9.4%	9.4%	407	1,356	DNP Urban Domestic Use (100 lcd)	6,101	0.10%

8.2 Economic Analysis

Economic analysis is carried out to evaluate the economic feasibility of the project through calculation of the economic internal rate of return (EIRR) for sewerage and drainage project components separately.

(1) Basic Assumptions

- Project lifetime 50 years
- Cost Capital expenditure (initial and reinvestment) and O&M cost
- Price escalation, taxes, interest during construction, and land acquisition costs are excluded from calculation.
- The threshold for economic viability is set at 8% considering recent similar Japanese ODA projects in Viet Nam in the sewerage and drainage sector.

(2) Sewerage Component

Benefits quantified in the analysis are as follows:

(i) Land value increase of 3% over five years after commissioning

(ii) Avoided sanitation cost in terms of septic tank construction and operation

(iii) Avoided healthcare cost related to diarrheal disease

(iv) Increase in fishery production

EIRR is estimated as 12.5%. Sensitivity analysis results show the EIRR's relative sensitivity to capital cost increase.

Table S-12 Sensitivity Analysis Results (Sewerage)

Base: 12.5%		Capital Cost				
		+ 0.0%	+ 2.5%	+ 5.0%	+ 7.5%	+ 10.0%
O&M Cost	+ 0.0%	12.5%	11.6%	10.7%	9.6%	*Below 8.0%*
	+ 2.5%	12.2%	11.4%	10.4%	9.1%	*Below 8.0%*
	+ 5.0%	12.0%	11.1%	10.0%	8.4%	*Below 8.0%*
	+ 7.5%	11.8%	10.8%	9.6%	*Below 8.0%*	*Below 8.0%*
	+ 10.0%	11.5%	10.5%	9.1%	*Below 8.0%*	*Below 8.0%*

(3) Drainage Component

Benefits quantified in the analysis are:

(i) Avoided property damage (buildings and movables) due to floods

(ii) Avoided household income loss due to floods

(iii) Avoided agricultural loss due to floods

EIRR is estimated as 8.9%. Sensitivity analysis results show the EIRR's high sensitivity to capital cost increase.

Table S-13 Sensitivity Analysis Results (Drainage)

Base: 8.9%		Capital Cost				
		+ 0%	+ 5%	+ 10%	+ 15%	+ 20%
O&M Cost	+ 0%	8.9%	8.5%	8.2%	*7.9%*	*7.6%*
	+ 5%	8.9%	8.5%	8.2%	*7.8%*	*7.5%*
	+ 10%	8.9%	8.5%	8.2%	*7.8%*	*7.5%*
	+ 15%	8.9%	8.5%	8.1%	*7.8%*	*7.5%*
	+ 20%	8.9%	8.5%	8.1%	*7.8%*	*7.5%*

9. Environmental Consideration

This project will contribute to the reduction of pollution and improved drainage. Benefits include improved public health and sanitation, and increased economic development. Downstream beneficiaries include a large population in Ho Chi Minh City that uses the Dong Nai River as a source of potable water. Limited adverse impacts generated by the project will be avoided or reduced to acceptable levels by appropriate mitigation measures. Resettlement of households affected by land acquisition will be appropriately compensated. The benefits significantly outweigh the limited negative impacts.

9.1 Review of EIA

1) The current EIA was approved by DNPPC on February 2009 for the full scope of work identified in the F/S.

2) As noted and approved by DNPPC decision No. 762 UBND-CNN on 25th January 2011, and No. 63A BQLTN on 6th April 2011 a supplemental EIA is not required because the components of the priority project I are within the scope identified in the F/S.

3) The current EIA was checked by the JICA Study Team for compliance with JBIC guidelines for "EIA Reports for Category A Projects". There are a few differences in the current EIA report that must be addressed to satisfy the JBIC guideline:

   - Appendices in the EIA report should be translated to English

9.2 Screening

1) The JICA Study Team has screened the project and confirmed that it is classified as category A because it requires the resettlement of residents at the STP and PS sites and for access roads along proposed drain improvements.

9.3 Environmental Checklist

1) The environmental checklist describes physical, biological and socio-economic conditions, including all changes anticipated before the project commences.

2) The JICA study team confirms that all the items on the checklist have been properly reviewed and addressed by the approved EIA report.

10. Social Consideration

The construction of STP2, pumping station (PS1) and canal improvements requires permanent land acquisition causing resettlement of residential households. A preliminary estimate indicates that the total number of affected households could be more than 1,100 for the implementation of this Project. Partial land acquisition will be required in about 900 cases while the rest will require complete land acquisition and resettlement to a newly developed relocation site. A total of 88 households are affected at the site of STP2; 75 of these will face full land acquisition. STP2 will require a total land acquisition of around 93,000 m^2. For PS1, about 6,400 m^2 of land is required. The land requirements for the stream improvement are 137,400 m^2 for San Mau, 24,400 m^2 for Linh Bayou, and 21,700 m^2 for Dien Hong stream. The land acquisition process has already been completed for the Linh stream improvement.

Land Law No.13/2003/QH11 and subsequent laws and regulations stipulate the land acquisition and resettlement process. There are also specific regulations promulgated by DNPPC on the resettlement procedure and determination of compensation price applicable to Dong Nai province.

Japan's ODA Charter states that in formulating and implementing assistance policies, factors such as environmental and social impacts must be carefully considered and mitigated. In the scope of this Preparatory Study, JICA mentions that it is desirable for the Resettlement Action Plan (RAP) to include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

RAP preparation and execution is the sole responsibility of the Vietnamese authorities. In December 2010 the JICA Study Team provided advice and support to the PMU on the RAP document so it could be prepared in a timely manner. Subsequently, the PMU prepared a RAP document with help from the Center for Land Development (CLD). The document was submitted to DNPPC for approval on 28th February, 2011. The JICA Study Team reviewed the RAP document and the review findings are summarized in the following paragraphs.

Field activities for compensation planning of the proposed site of STP2 were started in July, 2010. It is expected that field activities for the other components would start in the second quarter of 2011. The (2) proposed relocation sites and (1) apartment block are now being developed and are expected to be ready by 2011. Resettlement related activities are scheduled to be completed by March, 2012 for the STP2 site and September 2012 for the PS1 site and canal right-of ways.

The total estimated cost for RAP implementation is 404 billion VND, equivalent to around 20 million USD. The resettlement cost for the STP2 site is 152 billion VND and that for the PS1 site and canal right-of-ways is 252 billion VND. However, the number of affected properties is preliminary and as mentioned in the RAP document the final compensation plan will be prepared after the completion of the inventory survey. Scheduled dates for preparation of these plans are April 2011 for STP2 and November 2011 for PS1 and canal right-of-ways. Planned approval dates for the compensation plans are June 2011 and January 2012, respectively.

The JICA Study Team recommends that the PMU make the compensation plans available to JICA at or before the time of project appraisal for ODA finance.

11. Operation and Effect Indicator and Monitoring

The operation and effect indicators and these targets are determined to evaluate the progress in achieving the benefits of the Project as shown in Table S-14.

Table S-14 Performance Indicators and Targets

Indicator	Present (year 2011)	Target (year 2021)
Volume of Sewage Treated (m^3/d)	0	41,500
Population Served (Persons)	0	188,000
Number of House Connection (Households)	0	28,700
Percentage of the Population Served in the priority area(%)	0	100
Quality of Treated Effluent	BOD_5: － SS : －	BOD_5 ＜ 30 mg/L SS ＜ 30 mg/L
Sewers: Flooded area for rainfall with intensity of less than 80.0 mm/hr (5-year return period)	130 ha	0 ha
Canals: Flooded area for rainfall with intensity of less than 57.0 mm/hr (1-year return period)	110 ha	0 ha

12. Conclusions and Recommendations

12.1 Sustainability

The sustainability of project benefits would be achieved through: (i) use of innovative technology which is appropriate for the local conditions; (ii) Government's commitment to capacity building for O&M; and (iii) implementation of an appropriate tariff. The lessons learned during project design and implementation would be incorporated in the preparation of any follow-up projects, thereby enhancing the sustainability of the larger initiative in Bien Hoa, if such an initiative is undertaken.

12.2 Risks and Mitigation Measures

Risks to the successful implementation of the project are identified in Table S-15.

Table S-15 List of Risks and Mitigation Measures

Risk	Risk Mitigation Measure
Cost increase: if there are contract variances for building foundations and soil improvement works.	Detailed geotechnical investigations at the design stage including a plate bearing test. The tender documents shall specify the Bidder’s responsibility to do carry out an independent soil investigation.
Cost increase: contract variances for pipe trenching and bedding.	Proper technical specifications shall be prepared to meet project specific conditions
Cost increase: if there are contract variances for road and railway crossings.	The scope of work and costs will be discussed with local authorities having jurisdictional responsibility. Agreed provisional sums shall be included in the tender documents.
Delay to the start of trunk sewers and treatment plant if the Cai Riverside Road is not constructed before the project begins.	The PMU shall implement an IEC campaign that will include communication and coordination with the agencies responsible for the construction of Cai River Road. Priority shall be allocated to funding the Cai River Road project.
Low inflow of sewage at the treatment plant if households are not connected to the sewer system.	The IEC campaign shall include aggressive promotion of house connections. A special unit will be created within the PMU to manage house connections and provide homeowners with technical assistance. Grants and a revolving loan fund will be provided to every household to help with the cost of making a connection.
Delay in the rehabilitation of canals if land for maintenance and construction access roads is not acquired before the start of the project.	The PMU, the center for land development and the PPC must take appropriate actions in effective and timely manner for clearing project sites before the construction.
Equipment and process malfunctions caused by poor staffing skills, and lack of funding.	Implement a capacity building program for O&M staff including technical assistance with operations for 1 year. Implement an appropriate increase in the environmental protection fee to cover the costs of maintenance and equipment replacement.

12.3 Conclusion

This project will contribute to the reduction of pollution and improved drainage. Benefits include improved public health and sanitation, and increased economic development potential. Downstream beneficiaries include a large population in Ho Chi Minh City that uses the Dong Nai River as a source of potable water. The Project also satisfies the priorities identified in National water sector policies.

The project will cost about $US 667 million and will require a significant investment in the form of bi-lateral aid. The Government of Japan has financed many sanitation projects in Viet Nam and is actively supporting improvements in the environmental sector. Proposed priority project I would be eligible for a Japanese yen loan with the following attractive on-lending rates: interest rate of 0.65%/year over a 40 year loan term, with a 10 year grace period. Financial support from JICA would give the project access to the knowledge base and lessons learned from other Japanese ODA projects as well as on-going technical assistance in the sector.

In consultation with the PMU the JICA study team has prepared two alternatives to reduce the scope and costs of the project if funding becomes a constraint. Project Alternative 1 is US$ 540 million and Alternative 2 is US$ 395. The rehabilitation of canals (except Bien Hung ditch diversion, Dien Hong Ditch and Linh Stream) has been removed from both Alternatives. In both alternatives the area to be serviced by separate sewers is progressively reduced by eliminating areas that are currently less developed.

Although reduced costs may make the project more financially viable, the expected benefits would not be as significant.

12.4 Recommendations

The items listed below should be undertaken during subsequent stages of the study or during the design and implementation periods:

(1) PPC and/or PMU should complete the compensation plan for the STP site before the appraisal mission of any potential donor including JICA.

(2) PPC and/or PMU should start field activities/ inventory survey for the pumping station and stream improvement as soon as possible. After completion of compensation planning for these areas, the outcome should be reported before the appraisal mission of any potential donor including JICA.

(3) PPC and/or PMU should coordinate activities of Cai River Side Road and sewerage projects with relative agencies, and share information with them to avoid potential delays in construction of main trunk sewer.

(4) Detailed geotechnical investigations shall be carried out during the design stage for:

- STP site to confirm the structural requirements for foundations of each structure.

- Pumping stations, and pipe ditches to prepare appropriate temporary works and foundation, and to select economical and safe construction methods.
- The tender documents shall also specify that the Bidder's are responsible for carrying out an independent investigation of soil conditions.

(5) Preparation of appropriate regulatory arrangements and work procedures for sewerage house connection is recommended at the detailed design stage.

CHAPTER 1 INTRODUCTION

1.1 Background

Bien Hoa City in Dong Nai Province, Ho Chi Minh City, and Vung Tau City in Ba Ria Vung Tau Province are developing into strategic economic zones in the southeastern region of Viet Nam. Dong Nai Province attracted foreign investment amounting to USD 12,824 million in 2007, the third highest in the country, following Ho Chi Minh City and Hanoi City. In terms of investment from Japanese enterprises, Dong Nai province ranks first in Viet Nam.

In the midst of the economic advancements, sewage collection and drainage systems are not well developed compared with other urban infrastructure taking place in Bien Hoa City. Only 40% of the city has sewage collection and drainage facilities or has made plans for them. There is no sewage treatment plant in the city. Untreated sewage is discharged directly to open channels that drain to the Dong Nai River, which is also a water source for Ho Chi Minh City's domestic water supply system. The effect on the water environment is serious and the development of infrastructure for sewerage is an urgent issue for Bien Hoa City.

Localized flooding frequently occurs when there is heavy rainfall. The problem in some areas is aggravated by the influence of high tides on river water levels. Flooding damages properties resulting in economic losses. Flooding also affects the flow of traffic. Flood water is a mix of raw sewage and urban runoff that is very unsanitary and presents a risk to public health. Poor drainage can also lead to problems with odor, mosquitoes and fly breading which can have an impact on public health.

The accumulation of garbage and sediment in surface drains greatly reduces flow capacity. In other cases development has encroached on drains reducing the cross section. Continued urbanization will result in more impervious surfaces creating even more surface water thereby increasing the size and frequency of floods. There is therefore an urgent need to improve drainage in Bien Hoa City to mitigate future flood damages, improve living conditions and reduce the risk to public health.

Recognizing the importance of improving the water environment and the general wellbeing of its residents, the Dong Nai Province People's Committee (DNPPC) prepared master plans for water supply and sewerage/drainage for both urban and industrial development areas (target year 2020). In 2008 they subsequently executed a feasibility study (F/S) for key infrastructure components identified in the master plans. Based on the F/S, DNPPC requested a Japanese Yen Loan from JICA to implement the Dong Nai Water Improvement Project comprising the development of sewerage/drainage facilities in Bien Hoa City and Phase II of the Nhon Trach Water Supply Project.

In response to the request for funding JICA sent a preparatory study team to work on the Dong Nai Water Environment Improvement Project (hereafter called the Phase I Study) from February and May 2010. The team reviewed DNPPC's master plans and F/S, collected and analyzed basic data to determine the necessity of the project, and examined the feasibility of implementing various priority projects in different groupings.

In the Phase I Study, the necessity of sewerage and drainage projects in F/S area (about 3,790 ha) was confirmed, and project components appropriate for Japanese Official Development Assistance (ODA) were proposed. Sewerage projects are needed because the canals in Bien Hoa City have almost the same water quality as raw sewage, incidences of waterborne diseases are reported every year, and there is no centralized sewerage treatment system. Drainage projects are also a necessity because of the inundation experienced in the area and the lack of maintenance of canals. The F/S area was divided into three priority areas for implementing sewerage systems, according to pollutant load generated, population and water consumption per capita. Sewerage in the Central area (about 1,072 ha) is a high priority project because of the significant pollutant load generated by wastewater, the large served population and existing high water consumption per capita. As for drainage systems, four of the eight major drains (San Mai, Linh Bayou, Bien Hung, and Dien Hong) where flooding has been confirmed are the priorities.

In preparation for funding by Japanese ODA Loan, JICA dispatched the present Study Team in November 2010 to prepare the project implementation plan for the priority projects identified in the Phase I Study. The current preparatory mission is referred to as the Phase II Study.

1.2 Review of Relevant Plans and Studies

1.2.1 Urban Development Plan in Bien Hoa City

The Urban Development Plan for Bien Hoa City is described in "The Adjusted General Planning of Bien Hoa City to the year 2020" approved by the Prime Minister on November 6, 2003 (hereinafter referred to as "Approved General Plan" (AGP)). Tables 1.2.1 and 1.2.2 summarizes the population projections and water supply plan to 2020 as stated in the AGP.

Table 1.2.1 Population Projections in the Approved General Plan

(unit: person)

Year	2002 (Result)	2010	2020
Whole City	508,438	645,000	830,000
Urban Area	476,452	615,000	800,000

Source: The Adjusted General Planning of Bien Hoa City to the year 2020

Table 1.2.2 Water Demand in the Approved General Plan

Year	2010	2020
Water Consumption (l/c/d)	150	165
Water Demand (m^3/d)	-	360,000

Source: The Adjusted General Planning of Bien Hoa City to the year 2020

In the Approved General Plan, the population estimate for the year 2020 is based on the assumptions that the population density would be relatively high about 130 people/ha and that land use will be about 90% non-agricultural i.e. residential, commercial, industrial lands etc.

1.2.2 Master Plan for Sanitation and Drainage in Bien Hoa City

As required by the National Policy, Dong Nai Province prepared the “Master Plan on Sewerage and Environmental Sanitation for Urban and Industrial Zones in the Area of Bien Hoa City (2003-2020)” (hereinafter referred to as “Master Plan”). The master plan was approved by DNPPC on May 21, 2004 (Decision No. 1891/QD.CT.UBT). The master plan was prepared based on the “Decision on Ratifying the Orientation for the Development of Urban Drainage in Viet Nam up to the year 2020” (Decision No.35/1999/QD-TTg of March 5). In this decision, it was planned that a city should have its own sewerage system and should provide sewage treatment and drainage services for 90-100% by 2020.

An outline of the Master Plan is provided below.

(1) Study Area and Population

The study area is the whole of Bien Hoa City. The projected populations of Bien Hoa City are 650,000 people in 2010 and 830,000 people in 2020, similar to the projections in the Approved General Plan. The urban and sewerage service population in the Approved General Plan was projected to be 800,000 in 2020.

Table 1.2.3 Population Projections as per the Master Plan

(unit: person)

Year	Status	Estimation	
	2000	2010	2020
Whole City	481,957	650,000	830,000
Urban Area	-	-	800,000

Source: Master Plan on Sewerage and Environmental Sanitation for Urban and Industrial Zones in Area of Bien Hoa City (period 2003-2020)

(2) Planned Phases

The planning period is divided into Phase I, from 2003 to 2010 and Phase II, from 2010 to 2020.

(3) Sewerage

1) Proposed Type of Sewage Collection System

Separate system would be employed in new or developing urban areas and combined system for developed areas with existing combined collection system.

2) Sewerage Facilities

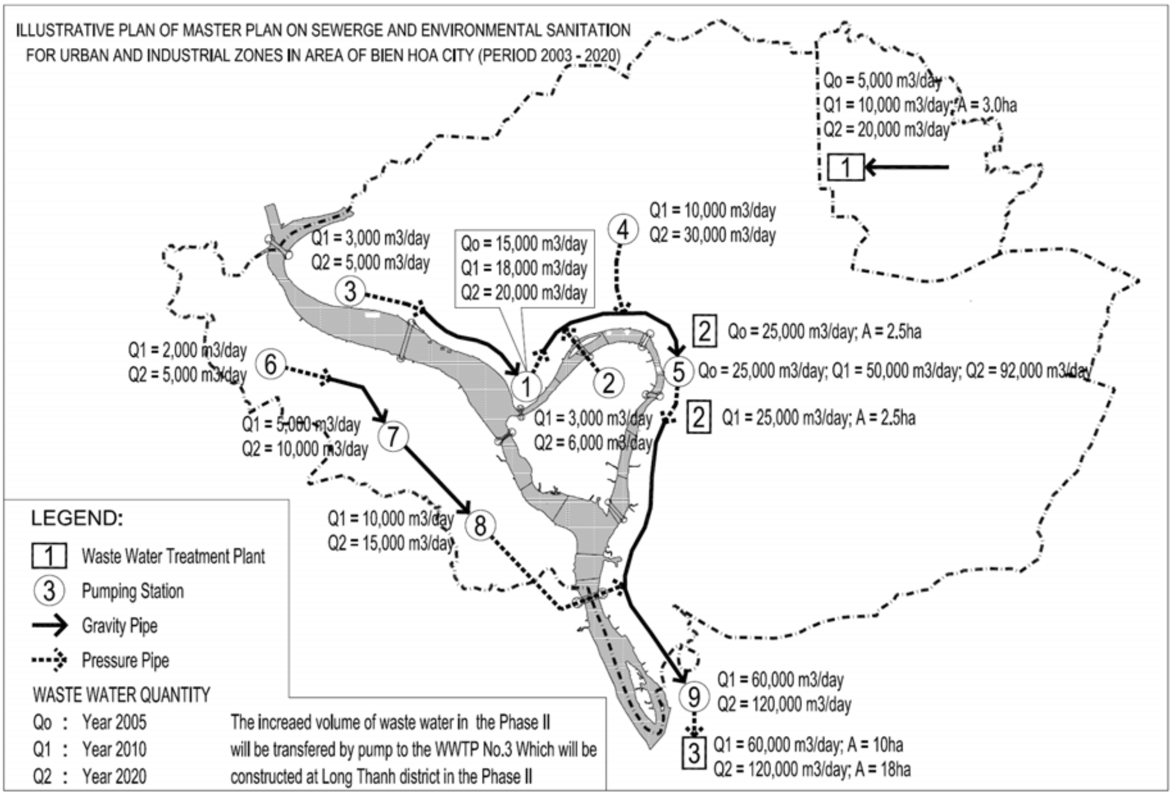
Sewage flow rate is estimated based on the water consumption identified in the APG as shown in Table 1.2.4.

Table 1.2.4 Water Consumption

Year	2010	2020
Water consumption (l/c/d)	150	165

Source: Master Plan on Sewerage and Environmental Sanitation for Urban and Industrial Zones in Area of Bien Hoa City (period 2003-2020)

The plan for the sewerage system is presented in Figure 1.2.1. The plan identifies three sewerage treatment plants with capacities of 15,000 m^3/d for STP1, 50,000m^3/d for STP2, and 120,000m^3/d for STP3, and nine pumping stations. The sites for 2 treatment plants are identified. The location for the third plant has not been determined as of end of April, 2011.



Source: Master Plan on Sewerage and Environmental Sanitation for Urban and Industrial Zones in Area of Bien Hoa City (period 2003-2020)

Figure 1.2.1 Master Plan for Sewerage

(4) Drainage System

1) Return period

Drainage system is designed based on three-year return period for the Category I channels and one-year return period for Category II and III channels.

2) Drainage Facilities

Five flap gates, two detention reservoirs and storm sewers are planned based on the return period.

1.2.3 Feasibility Study for Phase I of Sewerage and Drainage Project

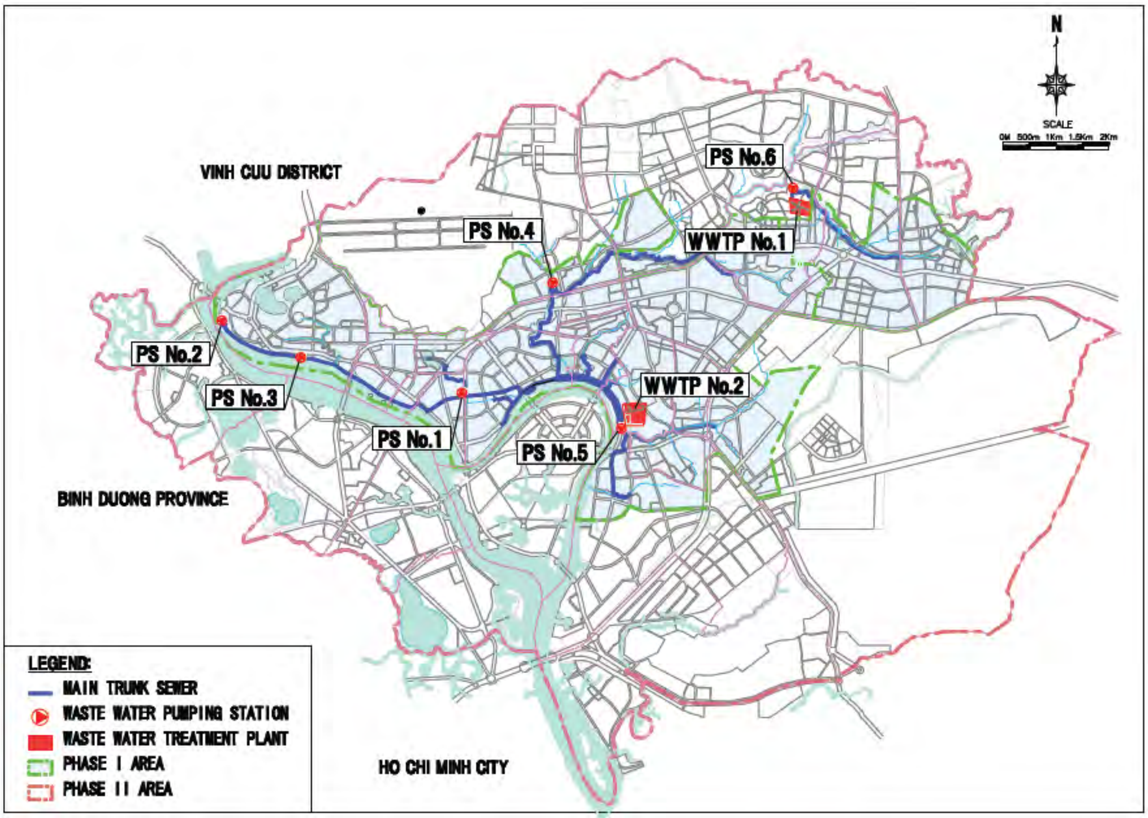
The "Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I to the year 2010" (F/S Report) was prepared by local consultants based on the Master Plan. This F/S Report was approved by DNPPC on April 14, 2008. The outline of the F/S Report is summarized below.

(1) Investment Objectives:

The investment would reduce flooding incidences, prevent contamination of the surface water and ground water by wastewater, improve public health and contribute to economic growth through the construction of sewerage and sewage treatment systems in Bien Hoa City.

(2) Phase I (F/S) Area

The proposed project area for Phase I is 3,635 ha in 20 wards of Bien Hoa City as shown in Figure 1.2.2.



Source: JICA Preparatory Study Phase I

Figure 1.2.2 Project Area in F/S report

(3) Sewerage

Facilities to be constructed in Phase I are shown in Table 1.2.5 to Table 1.2.7. The total length of main and branch sewers is approximately 133 km, not including tertiary sewers, connection pipes, and private sewers. The length of storm pipes in the separate sewer area is approximately 235 km.

Table 1.2.5 Sewer Lengths of Phase I in F/S

No.	Type of Sewer	Length (m)
		2010
Sanitary Sewer		
1	Gravity Sewer	124,950
2	Interceptor	6,542
3	Pressure Pipe	1,310
Total		132,802
Storm Sewer		
1	D400-1800, BC 2.0 x 1.6	18,015
2	D400-1800, BC 2.5 x 2.0	32,300
3	D500-1800, BC 2.5 x 2.0	26,590
4	D400-1800	26,320
5	D400-1800, BC 2.0 x 2.0	43,165
	D300-D400	89,450
Total		235,840

Source: Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I to the year 2010

Six pumping stations and two sewage treatment plants (STPs) with capacities of 9,500 m^3/d and 52,000 m^3/d are planned. The sites of the STPs were decided in DNPC Decision No. 4507/QD-JBND as of December 21, 2007. In the process of land acquisition, notification of land acquisition to people living in the sites of the STPs was conducted in 2009. The Compensation, Support and Resettlement (CSR) Council for STP No. 2 has been organized. The council prepared the CSR plan and proposed compensation rates.

Table 1.2.6 Capacity of Sewage Pumping Stations

No.	Capacity(m^3/d)
PS1	19,900
PS2	1,700
PS3	3,100
PS4	6,300
PS5	52,100
PS6	9,700
Total	92,800

Source: Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I up to the Year 2010

Table 1.2.7 Location and Land Area of STPs

Name	Location	Land Area (m^2)
STP No. 1	Ho Nai Ward	94,000
STP No. 2	Tam Hiep Ward	93,420

Source: Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I to the Year 2010

(4) Drainage System

The drainage system is designed based on the rainfall return period. Rehabilitation and dredging are planned for canals in Phase I as shown in Table 1.2.8 and Figure 1.2.3. Tan Mai and Ba Bot were rehabilitated in 2002. Access roads were requested for Tan Mai and Ba Bot streams in the F/S report. The others are natural canals surrounded by wetlands or houses without proper access for maintenance.

Table 1.2.8 Canals of Phase I Program in F/S

No	Name	Length	B(bottom)	Slope	Height
		m	m		m
Entire Rehabilitation					
1.1	Lung ditch	710	3.0	1	2.0
1.2	Lung ditch	860	6.0	1	2.5
2.1	Bien Hung ditch	680	1.6		2.0
3.1	Dien Hong ditch	820	4.0		2.0
3.2	Dien Hong ditch	500	15.0	1	2.5
4.1	San Mau stream	3,600	5.0	1	1.8
4.2	San Mau stream	2,625	7.5	1	2.2
4.3	San Mau stream	470	2.0	1	2.0
4.4	San Mau stream	610	2.0	1	2.0
4.5	San Mau stream	1,260	2.5	1	2.0
4.6	San Mau stream	740	7.5	1	2.5
5.1	Linh Bayou	1,060	3.0	1	2.0
6.1	Linh Bayou	1,200	3.0	1	2.0
7.1	Ong Gia	1,550	4.0	1	2.5
7.2	Ong Gia	530	10.0	1	2.5
Total		17,215			
Partial Rehabilitation					
8.1	Tan Mai stream	2,150			
8.2	Ba Bot stream	920			
Total		3,070			
Grand Total		20,285			

Source: Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I to the Year 2010

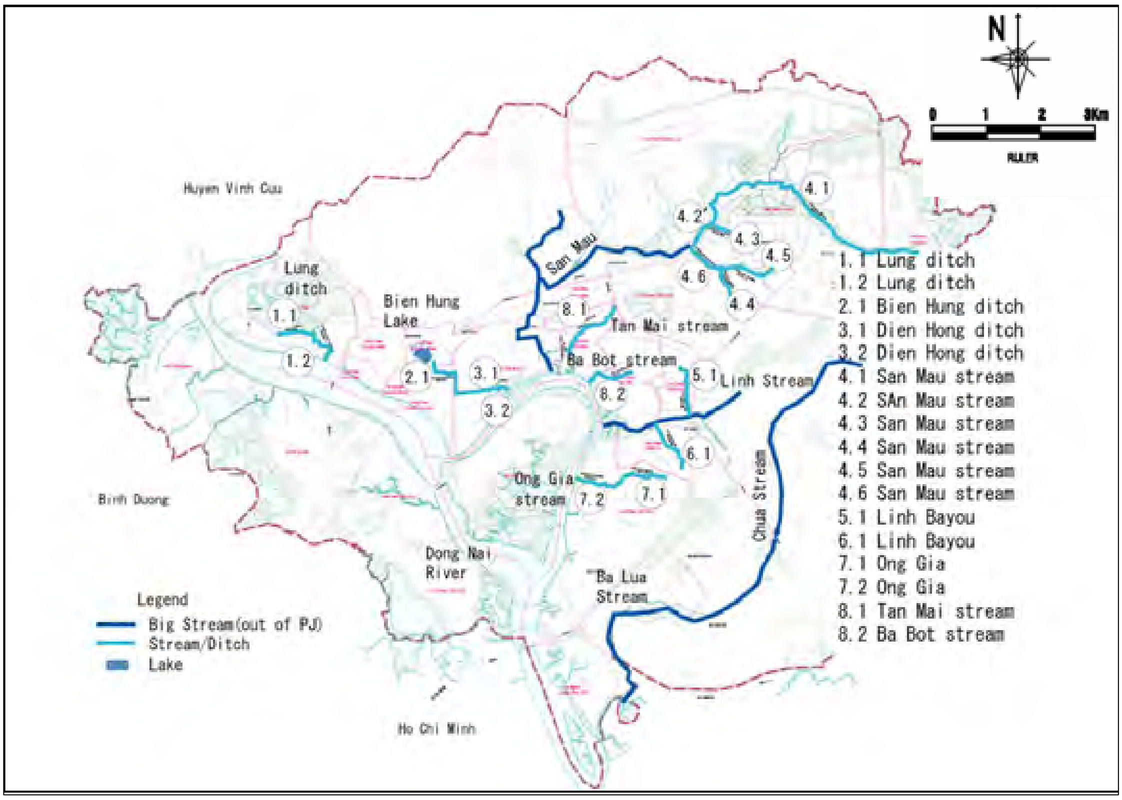
(5) Environmental Impact Assessment (EIA)

EIA on the construction projects was conducted in 2008. The EIA report was approved by the Dong Nai PC in February 2009 (No: 426/QD-UBND).

The EIA analyzed the following:

- Existing environment quality in the project site in terms of natural conditions, socio-economic situation, technical infrastructure, environments of soil, water and air, and eco-system; and
- The project’s positive and negative impacts on the local environment (qualitative and quantitative).

The report proposed measures to control and minimize environmental pollution and mitigate environmental problems. Establishment of programs on environmental quality supervision and management was also suggested.



Source: JICA Preparatory Study Phase I

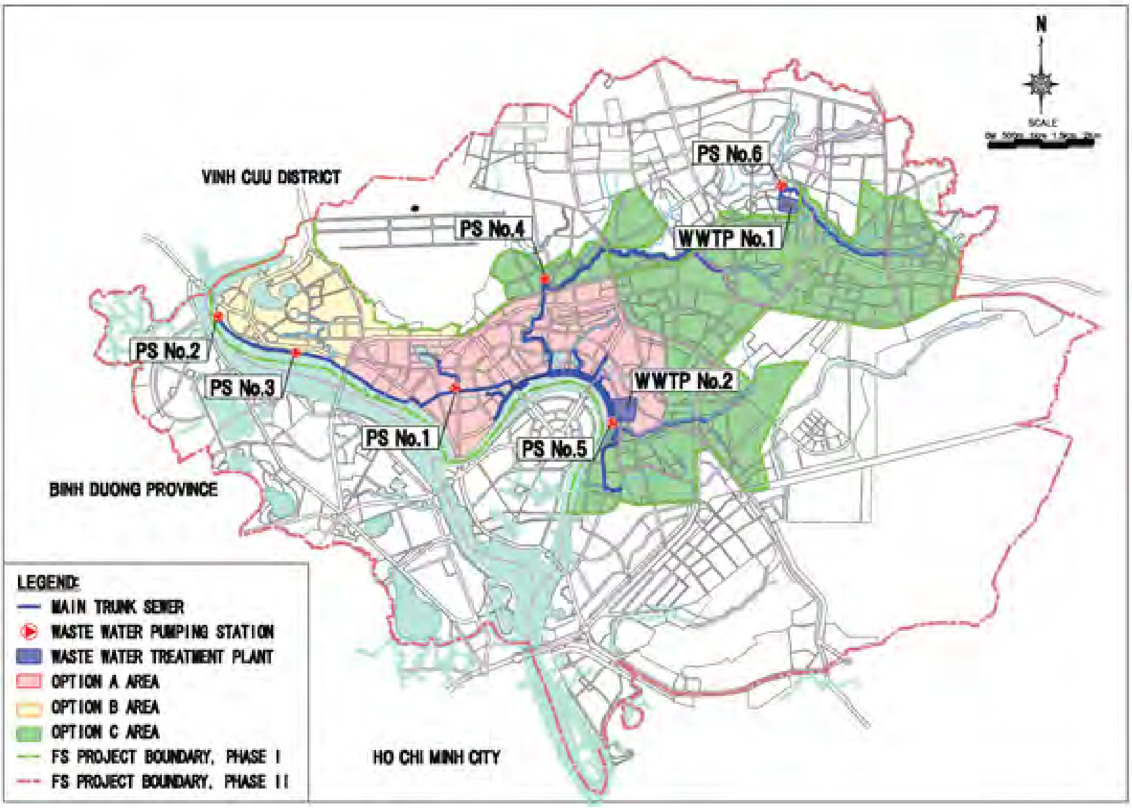
Figure 1.2.3 Canals of Phase I Program in F/S

1.2.4 The Preparatory Study for Dong Nai Water Environmental Improvement Project in June 2010 (Phase I Study conducted by JICA)

The projects proposed in the F/S were reviewed in terms of urgency and priority to determine whether they would be appropriate for Japanese ODA.

For sewerage, Phase I study area is divided into three areas for this evaluation. The evaluation and appropriate magnitudes of initial investment are as shown in Figure1.2.4. Option A, colored pink is a central area including Dong Nai PPC. Option B, colored yellow is an area in the west and Option C colored green is in the east.

Based on the evaluation (Table 1.2.9), Option A has high urgency and priority due to high pollution load production and large service population, and would be easily implemented by changing the sewer route. Other options are not as urgent because of low pollution load and smaller service population. Therefore, projects in Option A are proposed as the most effective projects to improve the present water environment.



Source: JICA Preparatory Study Phase I

Figure 1.2.4 Division of F/S Study Area

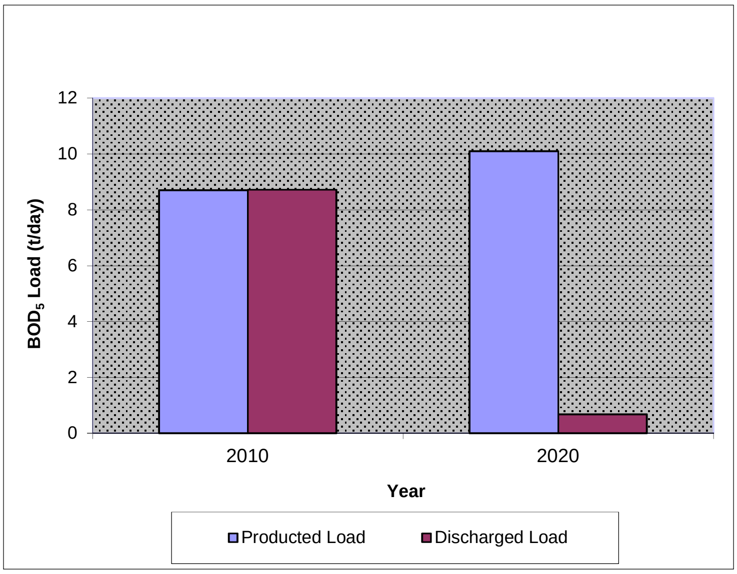
Table 1.2.9 Evaluation of Project Package for Sewerage System

	Option A	**Option B**	**Option C**
Project Components	- WWTP No. 2 - Pumping stations No. 1 & No. 5 - Main trunk sewer, branch sewer and storm sewer - Tertiary sewer - Connection pipe - Private sewer	-WWTP No. 2 - Pumping stations No. 1, No. 2, No. 3 and No. 5 - Main trunk sewer, branch sewer, and storm sewer - Tertiary sewer - Connection pipe - Private sewer	-WWTP No. 1 -WWTP No. 2 - Pumping stations No. 4, No. 5 & No. 6 - Main trunk sewer, branch sewer, and storm sewer - Tertiary sewer - Connection pipe - Private sewer
Size of Area	1,072 ha	504 ha	2,214 ha
Covered Population	145,388 persons in 2010 (135 pers/ha) 167,725 persons in 2020 (156 pers/ha)	33,716 persons in 2010 (66 pers/ha) 38,896 persons in 2020 (77 pers/ha)	219,635 persons in 2010 (99 pers/ha) 253,379 persons in 2020 (114 pers/ha)
Pollution Load Production*	8.1 kg as BOD/ha/d in 2010 9.4 kg as BOD/ha/d in 2020	4.0 kg as BOD/ha/d in 2010 4.6 kg as BOD/ha/d in 2020	5.9 kg as BOD/ha/d in 2010 6.8 kg as BOD/ha/d in 2020
Issues on WWTP	On the land acquisition process, CSR plan was prepared. PMU has been waiting for the decision of the PC on land acquisition. It is important to continue to follow the process of land acquisition. It is possible to build a 40 m buffer zone. To build 40 m buffer zone, odor treatment and mechanical dewatering are required. Also, the plant should be covered. The process and structure of	Same as Option A.	Same as Option A. It is necessary to acquire land for the WWTPs although there is no household in the site of WWTP No. 1.

	the plant should be studied. Moreover, since some sludge treatment can contribute to the mitigation of climate change, sludge treatment process should be examined in the next study.		
Issues on Pumping Station	Location of PS should be decided in the next study.	Same as Option A.	Same as Option A.
Issues on Main Trunk Sewer and Branch Sewer	Some sewers are proposed under the planned road. If planned road is not constructed, the installation of sewer is possible by changing the sewer route under the existing road.	Same as Option A.	Some sewers are planned under the riverside. If canal improvement is not constructed, the installation of sewer is possible by changing the sewer route under the existing road.
Possibility of Implementation	Present plan is affected by the road plan. However, it is possible to implement the projects by changing the sewer route.	Same as Option A.	Present plan is affected by the canal improvement. However, it is possible to implement the projects by changing the sewer route.
Urgency	Urgency is high because of high pollution load production at present and future.	Urgency is low because of low pollution load production compared to Option A.	Urgency is average because of average pollution load production compared to Option A.
Priority	Priority is high because served population is high and high pollution load is discharged into the river at present.	Priority is low since it has low service population and low pollution production load at present.	Priority is average since it has low service population and average pollution production load at present.
Evaluation	High	Low	Average

Note:* Pollution Load Production (kg as BOD/ha/d) = Population×60 g as BOD/c/d÷Area (ha)÷1000 (g/kg)
Source: JICA Preparatory Study Phase I

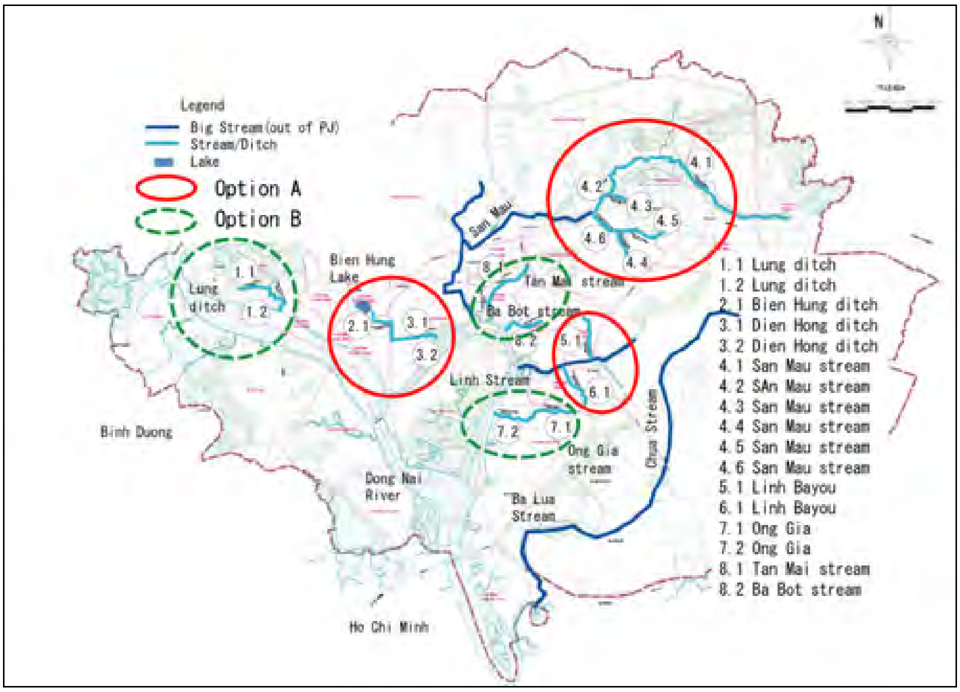
The effect of sewerage projects proposed in Phase I Study (Option A) is shown as BOD_5 reduction in Figure 1.2.5. About 90% reduction of BOD_5 load is expected.



Source: JICA Preparatory Study Phase I

Figure 1.2.5 Impact of Proposed Sewerage Projects (Option A) on BOD load

In terms of rehabilitation of canals, targeting the ones with reported flooding incidences would have the most impact on mitigation of future disasters. Therefore these are of higher priority and are grouped as Option A. The remaining ones in Option B have no previous flooding reports and are classified as lower priority. See Figure 1.2.6 and Table 1.2.10 for details.



Source: JICA Preparatory Study Phase I

Figure 1.2.6 Options for Drainage System Improvements

Table 1.2.10 Evaluation of Each Option for Improvement of Canals

	Option A	Option B
Project Component	2.1 Bien Hung ditch 3.1 Dien Hong ditch 3.2 Dien Hong ditch 4.1 San Mau stream 4.2 San Mau stream 4.3 San Mau stream 4.4 San Mau stream 4.5 San Mau stream 4.6 San Mau stream 5.1 Linh Bayou 6.1 Linh Bayou	1.1 Lung ditch 1.2 Lung ditch 7.1 Ong Gia 7.2 Ong Gia 8.1 Tan Mai stream 8.2 Ba Bot stream
Issues	Land acquisition is necessary for the canal improvement. It is important to steadily follow the process of land acquisition.	Same as option A.
Possibility of Implementation	It is possible to be implemented after land acquisition.	Same as option A.
Urgency and Priority	Because severe flood disaster is reported, urgency and priority are high.	Urgency and priority are lower than Option A because severe flood disaster is not reported.
Evaluation	High	Average

Source: JICA Preparatory Study Phase I

The following programs for improving sewerage and drainage systems were proposed in the Phase I Study.

- Priority area of 1,072 ha (971 ha measured excluding water surface and large park areas), consisting of 293 ha (272 ha excluding water surface and large park areas) of combined sewer and 779 ha (699ha excluding water surface and large park areas) of separated sewer.
- Priority given to rehabilitation of four of the eight canals: Bien Hung ditch, Dien Hong ditch, San Mau stream, and Linh Bayou.
- One sewage treatment plant - STP2 and two pumping stations - PS1 and PS5.
- Connection pipe from public sewer to private sewer which was not listed in F/S report is proposed for providing early sewage treatment service.
- Procurement of O&M equipment for providing sustainable service.
- Engineering services such as tender assistance, capacity development, public awareness etc.

1.3 Objectives of the Current Preparatory Study Phase II

The purpose of the Phase II study is to formulate the project implementation plan for Japanese ODA Loan, based on the project components proposed in the Phase I Study.

1.4 Terms of Reference of the Study

The Terms of Reference of the study are summarized below.

(1) To review the Phase I Study, identify the issues to be addressed and determine the project scope.

A. Review and collect design conditions, and social and environmental conditions of the Phase I Study.
B. Review the necessity and priority of projects in sewerage and drainage system.
C. Review and confirm the related projects to sewerage planning, e.g. road construction.
D. Confirm the current conditions on resettlement since a large number of involuntary resettlement is expected to take place in the areas identified for the proposed project components in Phase I Study.
E. Review current and future programs for improvement of sewerage and drainage infrastructure.
F. Determine the project scope based on the items (A) through (E).
G. Review current status of operation and maintenance (O&M) (Including institutional arrangement and financial planning) of the sewerage and drainage sector.

(2) To formulate the component for improvement of sewerage infrastructure

A. Study the design parameters for facility size, sewage treatment process, and types of structures based on the sewerage development area, served population, sewage flow, and target effluent quality.

B. Prepare a preliminary design of sewerage facilities (e.g. construction of sewers, pumping stations and a sewage treatment plant, and procedures for obtaining the necessary permissions).

C. Estimate project costs based on the above item (2) B.

D. Study the private to public sewer connection methods.

E. Study the ways to improve wastewater disposal in areas outside the project area that are not served by sewers i.e. septic tanks and sludge collection

F. Calculate total annual O&M costs, household connection costs, and mid to long term management costs (including costs for replacement) and recommend an appropriate tariff and collection system.

G. Recommend an O&M improvement plan (including institutional arrangement and financial planning).

(3) To formulate the component to improve drainage infrastructure

A. Conduct drainage analysis and prepare a drainage plan.

B. Prepare a preliminary design for drainage upgrades (e.g. construction of floodgates, dredging of waterways and regulating reservoirs, rehabilitation of embankments, and procedures for obtaining necessary permissions) in the project area.

C. Estimate project costs based on the above item (3) B.

D. Recommend an O&M improvement plan (including institutional arrangement and financial planning).

(4) To assess project feasibility and implementation

A. Estimate internal rate of return (IRR) and determine operation and performance indicators.

B. Assist the stakeholders to reach consensus regarding the mandate, areas of responsibility and cooperation during the implementation of the project.

C. Assist the Vietnamese side, namely Dong Nai Management Unit for sewerage projects (PMU), and other related agencies and provide recommendations for capacity development.

D. Propose the implementation schedule and procurement procedure (bidding procedure, packaging arrangement, etc).

E. Propose approaches and methods for coordination with JICA and other donors.

F. Assess and recommend an appropriate policy to strengthen the project implementation.

(5) To review environmental and social considerations

A. Review EIA report, propose mitigation measures and assist in consultations with stakeholders, such as local residents.

B. Review current status and past lessons of resettlement programs in the project area.

C. Assist in the preparation of a Resettlement Action Plan (RAP) and in consultations with stakeholders, such as affected population.

D. Prepare environmental checklist (World Bank OP4.12 Annex A ‘Resettlement Plan’).

1.5 Structure of the Report

Investigation and analysis were carried out by the JICA Study Team from November 2010 to May 2011 in accordance with the TOR for Preparatory Study Phase II for the Dong Nai Water Environment Improvement Project (Sewerage and Drainage Sector). The study team traveled to Viet Nam to carry out two field investigations from November to April. This report presents the project scope, cost estimates, procurement schedules, environmental and social considerations, and economic analyses for Priority Project I. The four key components of the report are:

(1) Chapter 1 and Chapter 2

These chapters present the general background, relevant Plans and Studies, and Terms of Reference of the preparatory study, national policy related to water and sanitation, and laws and regulations relevant to the projects in the study area.

(2) Chapters 3 and Chapter 4

Chapter 3 describes the physical, socio-economic, and environmental conditions and existing drainage/sewerage systems of Bien Hoa City, the scope of works, and the justification for the project. Planning basis for sewerage and drainage systems, including design sewage flow and quality, type of sewage collection system, and selection of sewage treatment process are presented and discussed in Chapter 4.

(3) Chapters 5 through Chapter 12

Chapter 5 describes the proposed sewage collection and treatment facilities and their operation and maintenance requirements. Flood/inundation mitigation measures are discussed and preliminary plan and design of drainage system are presented in Chapter 6. Institutional arrangements for the construction and maintenance stages are presented in Chapter 7. It also includes the proposal for the modification of the Project Management Unit (PMU) to deal with house connections and O&M of the facilities. Other project components, including engineering services, such as detailed design and construction supervision, capacity building (C/B), and Information Education and Communication campaign (IEC) are presented in Chapter 8. Total project costs and required funding are calculated based on estimated construction and maintenance costs. Financial and economic analysis is described in Chapter 9. Environmental considerations including screening, environmental review and monitoring according to JBIC guideline are summarized in Chapter 10. Social considerations including the confirmation of present status of land acquisition and resettlement, review and recommendation of the Resettlement Action Plan (RAP) are presented in Chapter 11. The expected outcomes of the Priority Project I are described in Chapter 12.

(4) Chapter 13

This chapter presents the conclusions of the study and the recommendations for the project including risk and mitigation measures for the Priority Project I.

CHAPTER 2 NATIONAL POLICY AND STANDARDS

2.1 National Policy

The National Policy on Sewage and Drainage in Viet Nam is described in the "Decision on Ratifying the Orientation for the Development of Urban Drainage in Viet Nam up to the year 2020" (Decision No.35/1999/QD-TTg of March 5). The decision establishes that a city should have its own wastewater treatment system and should provide wastewater treatment and drainage services for 90-100% of its population by 2020.

Based on the National Policy, Dong Nai Province prepared The Master Plan (Decision No. 1891 / QD.CT.UBT). In 2008 Dong Nai Province prepared the F/S report to formulate projects in components planned in the Mater Plan.

2.2 Laws and Regulations Related to the Project

Vietnam's laws, regulations and decisions on construction, environmental protection, land use etc. relevant to the project are summarized in Table 2.2.1.

Table 2.2.1 Laws and Regulations Related to the Project

Law/Regulation	Contents
Land Use, Plan, Construction	
TSRVN NA No. 16/2003/QH11,11/05/2003	Construction Law
TSRVN NA No. 13/2003/QH11, 26/11/2003	Land Law
TSRVN NA No. 61/2005/QH11, 25/12/2005	Bidding Law
TSR VN No.32/2009/QH12	Law on Urban Planning
Decree No. 12/2009/ND-CP , 12/2/2009	Construction project
Decree No. 112/2006/ND-CP, 29/9/2006	Modification, amendment several point of No. 16/2005/ND-CP dated 7/2/2005
Decree No. 209/2004/ND-CP, 16/12/2004	Quality management of construction
Decree No. 131/2006/ND-CP , 09/11/2006	Management and utilization of ODA
Decree No. 41/2007/ND-CP , 23/3/2007	Urban underground construction
Decree No. 08/2005/ND-CP, 24/01/2005	Construction planning
Decree No. 172/ND-CP dated 3/12/2004	Compensation, assistance, and resettlement for land acquisition
Decree No.69/2009/ND-CP, 13/08/2009	Additionally providing for land use planning, land price, land recovery, compensation, support and resettlement
Circular No. 15/2005/TT-BXD of MOC, 19/8/2005	Guidelines on forming, appraising, and approval of construction planning
Circular No. 108/2003/TT-BTC, 07/11/2003 of BOF	Guidelines on the financial structure for sanitary environment project using ODA
Environment	
TSRVN NA no. 52/2005/QH11, 29/11/2005	Environment Protection Law
Decree No. 80/2006/ND-CP dated 09/8/2006	Guiding on detail implementation of some point of Environment Protection law
Circular No. 08/2006/TT-BTNMT of MONRE, 8/9/2006	Guidelines on strategic environment assessment, environmental impact assessment and commitment on environment protection

Law/Regulation	Contents
Water	
TSRVN NA No. 08/1998/QH10, 20/5/1998	Water resource Law
TCXDVN 33-2006	Design Standards for Water Supply System
Wastewater and Drainage	
Decree No. 88/2007/ND-CP, 28/05/2007	Wastewater discharge in urban and industrial areas
TCVN 7222:2002	General environmental requirement on WWTP
TCVN 5945:2005	Industrial wastewater standard
TCVN 7952:2008	Outdoor water drainage system and facilities – Design Standard
QCVN 14-2008/BTNMT	National Technical Regulation on Domestic wastewater
QCXDVN 01:2008/BXD	Construction Planning
QCVN-07:2010/BXD	Urban Engineering Infrastructures

CHAPTER 3 PRESENT CONDITIONS AND NEED FOR THE PROJECT

3.1 Description of the Study Area

3.1.1 Location

As described in Chapter 1 of the report, the study area is located in Bien Hoa City, which is the capital of Dong Nai Province. The center of Bien Hoa City has been defined as a high priority area for the development of sewerage and drainage because of a large service population, high levels of pollution in canals and high pollutant loads from wastewater.

3.1.2 Topography and Geography

Dong Nai Province is located in the south of Viet Nam. It is surrounded by Lam Dong in the north, Binh Thuan in the east, Ba Ria - Vung Tau in the south, Binh Duong, Binh Phuoc and Ho Chi Minh City in the west.

Bien Hoa City is located 30km northeast of Ho Chi Minh City on the left bank of the Dong Nai River. Bien Hoa City lies in an area that has a gradual slope towards the Dong Nai River; the elevation of highest area is 50m and the lowest area is 3m.

Dong Nai Province’s topography consists of plains and flat land with scattered, mountains and a gradual declivity in the southward direction. There are low-lying land areas in parts of Dong Nai Province, the depth of which varies from to 0.3 to 2 meters. These areas are usually permanently flooded by tidal waters. Some of these low-lying areas are covered by marine flooded forests.

Generally, the geological structure of Bien Hoa City was formed from volcanic sediments and river sediments, and it is mainly clay layers or loam layers that are solid when dry but rather flexible to fluid-plastic when hydrated.

The main soil types are bazan (dark yellow and red clay) and alluvial soil which are well suited to long-term cash crops like rubber, coffee, and fruit trees. Soil materials in the flooded areas are not homogeneous and consist mainly of clay and settled organic substances.

Information available from the WWF Viet Nam (World Wide Fund for Nature June of 2008), indicates that 15% (6,750/45,000 km^2) of the Dong Nai River basin had a soil erosion risk of 100 to 230 tons/ha/year. However, these areas are not included in the Bien Hoa City.

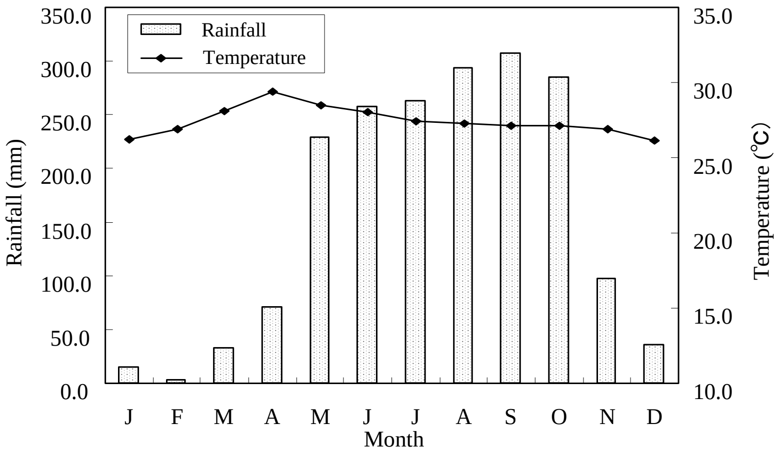
3.1.3 Climate

Dong Nai Province lies in the tropical monsoon zone and is affected by the north-east and south-west monsoon. It is also under the influence of Pacific Ocean tropical atmosphere between April and October. Its climate is divided in two distinct seasons. The rainy season lasts from

March or April to November and the dry season from December to March or April of the following year.

The average temperature is between 26ºC and 29ºC. The maximum monthly rainfall amount is 308 mm in September while the minimum is 3 mm in February. Humidity is constantly high throughout the year, as given in Figure 3.1.1. The total rainy days in a year are from 120 days to 170 days.

Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total or Average
Monthly Mean Temperature (℃)	26	27	28	29	29	28	27	27	27	27	27	26	27
Monthly Rainfall Amount (mm)	15	3	33	71	229	258	263	294	308	286	98	37	1,893
Monthly Relative Humidity (%)	76	71	71	75	86	86	85	87	88	87	85	81	82



Source: Southern Regional Hydro-Meteorological Center

Figure 3.1.1 Climatic Features of Dong Nai Province

The study area has been subjected to climate change effects; average temperature is predicted to increase by 0.7 degree and sea levels to increase by 200 mm by 50 years from now, according to the studies of the VAWR (Viet Nam Academy for Water Resources).

The meteorological station in Bien Hoa City shows that annual average temperature has increased by 0.8 degree from 1980 to 2007. The meteorological station in Tan Son Nhat, which is 26.5 km southwest from the center of Bien Hoa City, shows that annual rainfall has increased by about 110 mm from 1960 to 2007, according to IMHEN (Viet Nam Institute of Meteorology, Hydrology and Environment).

3.1.4 Hydrographical Features

(1) Hydrology of Dong Nai River

Dong Nai River is the largest river in the Southeast region of Viet Nam, with a total length of 586.4 km. Its total drainage basin is 40,683 km^2, and the section of the Dong Nai River running through Bien Hoa City has a length of 11 km. It is affected by the semi diurnal tidal regime of the South China Sea, and the water level at Bien Hoa City fluctuates from EL. 2.2 m to EL -2.1 m.

The Ho Tri An dam/reservoir located at upstream of the city controls the flow of the river. According to discharge records in 1989, the maximum and minimum discharges are recorded at 2,700 m^3/s and 158 m^3/s, respectively.

(2) Sea Water Intrusion into the Dong Nai River

The Dong Nai River downstream from Bien Hoa City has a slope of 1/27,000. Due to this moderate slope of the river bed, sea water penetrates as far as Bien Hoa City. Figure 3.1.2 shows raw water intake points affected by sea water. Bien Hoa City water supply intake is not affected by sea water intrusion, but the water supply intake for Ho Chi Minh City is affected by the sea water intrusion.

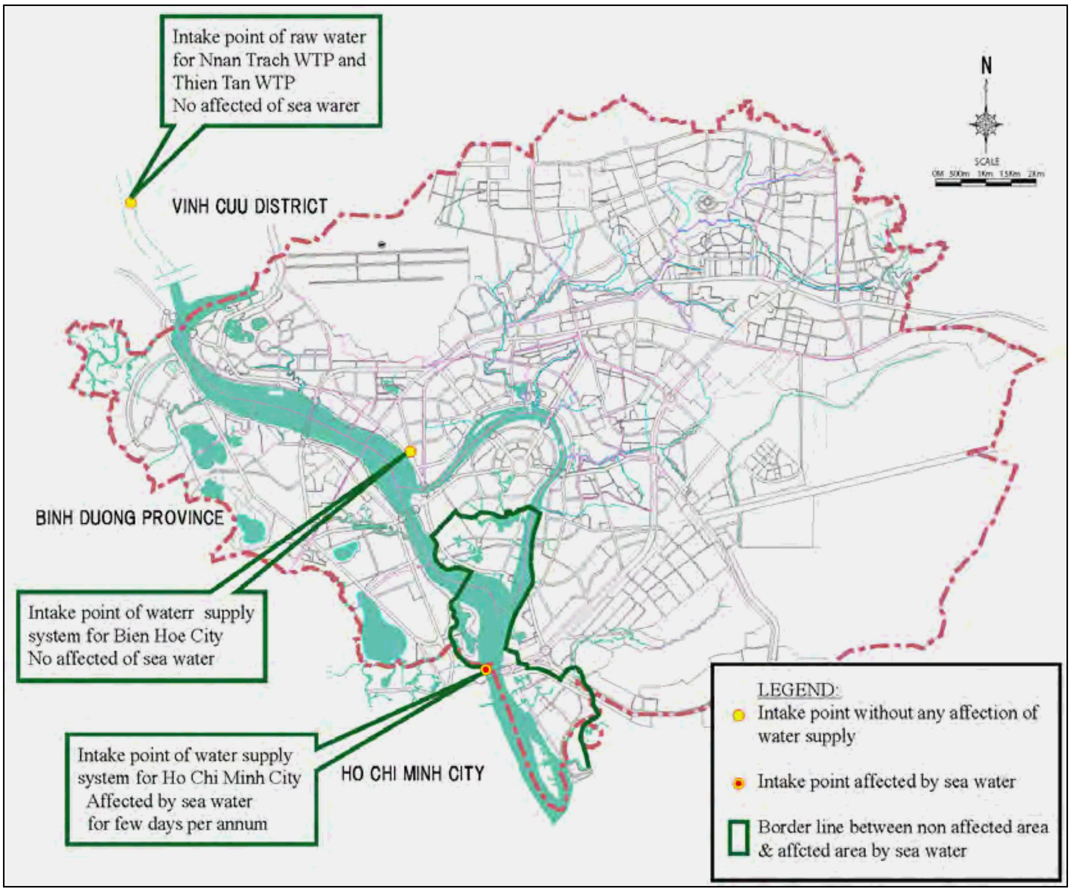


Figure 3.1.2 Influence of Sea Water Intrusion at the Intake Points of Water Supply System

(3) Groundwater

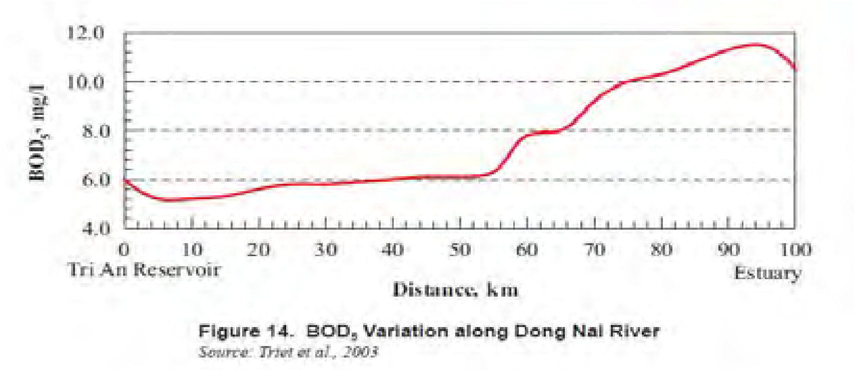
According to the information presented in the current Environmental Impact Assessment (EIA), aquifer layers around Bien Hoa City generally have hydraulic inter-linkages. The best sites for groundwater exploitation include the old-city centre, Tam Hiep and Ho Nai area, where the Knojoi aquifer is located.

According to the Ministry of Natural Resources and Environment (MONRE), the groundwater reserves in Bien Hoa City are depleted. Nowadays, there are over 14,000 wells in households that exploit groundwater without permission. However no firm conclusion can be made without further investigations to establish trends in changing groundwater levels.

(4) River Water Quality

According to the Institute of Global Environment Strategy, the Dong Nai River has been polluted by wastewater from urban areas in Dong Nai Province. Data indicates that river water quality downstream of Bien Hoa City deteriorates sharply in terms of BOD_5 as shown in Figure 3.1.3 and Figure 3.1.4.

Figure 3.1.3 Measurement Place of BOD_5 for Dong Nai River



Source: Sustainable Ground water management in Asian Cities, 2007 IGES

Figure 3.1.4 BOD$_5$ along the Dong Nai River Downstream of Tri An Lake

The water quality standard of Viet Nam is shown in Table 3.1.1 The BOD$_5$ of the Dong Nai River downstream of Ho Tri An Lake exceeds the national standards for rivers used for domestic water supply consumption (A1 and A2).

Table 3.1.1 Water Quality of QCVN 08-2008-BTNMT

No.	Specification	Unit	Limitation Values			
			A		B	
			A1	A2	B1	B2
1	pH		6-8.5	6-8.5	5.5-9.	5.5-9.
2	Dissolved Oxygen (DO)	mg/l	≥ 6	≥ 5	≥ 4	≥ 2
3	Total Suspended Solid (TSS)	mg/l	20	30	50	100
4	COD_{Cr}	mg/l	10	15	30	50
5	BOD_5 (20^{o}C)	mg/l	4	6	15	25
6	Ammonia (NH^+_4) (as N)	mg/l	0.1	0.2	0.5	1
7	Chloride (Cl^-)	mg/l	250	400	600	-
8	Fluoride (F^-)	mg/l	1	1.5	1.5	2
9	Nitrite (NO^-_2) (as N)	mg/l	0.01	0.02	0.04	0.05
10	Nitrate (NO^-_3) (as N)	mg/l	2	5	10	15
11	Phosphate (PO_4^{3-}) (as P)	mg/l	0.1	0.2	0.3	0.5
12	Cyanide (CN^-)	mg/l	0.005	0.01	0.02	0.02
13	Arsenic (As)	mg/l	0.01	0.02	0.05	0.1
14	Cadmium (Cd)	mg/l	0.005	0.005	0.01	0.01
15	Lead (Pb)	mg/l	0.02	0.02	0.05	0.05
16	Chromium III (Cr^{3+})	mg/l	0.05	0.1	0.5	1
17	Chromium VI (Cr^{6+})	mg/l	0.01	0.02	0.04	0.05
18	Copper (Cu)	mg/l	0.1	0.2	0.5	1
19	Zinc (Zn)	mg/l	0.5	1.0	1.5	2
20	Nickel (Ni)	mg/l	0.1	0.1	0.1	0.1
21	Iron (Fe)	mg/l	0.5	1.	1.5	2
22	Mercury (Hg)	mg/l	0.001	0.001	0.001	0.002
23	Detergent	mg/l	0.1	0.2	0.4	0.5
24	Total oils & grease	mg/l	0.01	0.02	0.1	0.3
25	Phenol (total)	mg/l	0.005	0.005	0.01	0.02
26	Chlorine compounds					
	Aldrin + Dieldrin	μg/l	0.002	0.004	0.008	0.01
	Endrin	μg/l	0.01	0.012	0.014	0.02
	BHC	μg/l	0.05	0.1	0.13	0.015
	DDT	μg/l	0.001	0.002	0.004	0.005
	Endosunfan (Thiodan)	μg/l	0.005	0.01	0.01	0.02
	Lindan	μg/l	0.3	0.35	0.38	0.4
	Chlordane	μg/l	0.01	0.02	0.02	0.03

No.	Specification	Unit	Limitation Values			
			A		B	
			A1	A2	B1	B2
	Heptachlor	μg/l	0.01	0.02	0.02	0.05
27	Phosphorous compounds Parathion Malathion	 μg/l μg/l	 0.1 0.1	 0.2 0.32	 0.4 0.32	 0.5 0.4
28	Herbicide 2.4D 2.4.5T Paraquat	 μg/l μg/l μg/l	 100 80 900	 200 100 1,200	 450 160 1,800	 500 200 2,000
29	Total radioactivity α	Bq/l	0.1	0.1	0.1	0.1
30	Total radioactivity β	Bq/l	1.0	1.0	1.0	1.0
31	E.coli	MPN/ 100ml	20	50	100	200
32	Total Coliform	MPN/ 100ml	2,500	5,000	7,500	10,000

Source: Viet Nam Regulation QCVN 08-2008-BTNMT

Notes: Quality of surface water is classified to evaluate and control for water utilization of different purpose as followings

A1: To use domestic water supply and others such as A2. B1 and B2

A2: To use domestic water supply but it is required proper treatment technology. and others such as B1 and B2

B1: To use irrigational purpose and others such as B2 category

B2: To use the waterway and other purposes with a low water quality treatment

3.2 Socio-Economic Conditions

Dong Nai Province, has an advantageous transportation system linking it to national backbone infrastructure such as Road 1A, Road 20, Road 51, and the North–South railway lines. Bien Hoa City is 30 km from Ho Chi Minh City, and 1,684 km from Hanoi. Also, nearby Saigon Port and Tan Son Nhat International Airport provide advantages to the economic activities in Dong Nai Province. Its location has helped it develop into a strategic economic hub at the junction of Tay Nguyen Highlands.

Total gross domestic product (GDP) of Dong Nai province in 2009 reached VND 15,036.7 billion (1994 constant prices). The economic condition of the province was stable, but the Consumer Price Index (CPI) in 2010 increased by 13.5%.

In 2010 the value of industrial production in the province increased by 17.6% over the previous year. As of late 2010, the province had 30 industrial zones which have been granted investment certificates with a total area of nearly 9,574 hectares, and the types of industrial production are diversified. In 2010, total retail sales of products and services rose by 26.6% over the previous year. Import and export activities are also expanding. In 2010 exports increased by 20.5% and imports increased by 22.8%.

The development of cultivated crops, key livestock and agricultural production has been stable because of favorable weather conditions. Also, many efforts have been made for the development of cultivated crop and livestock infrastructure including the implementation of technology transfer programs, and the replication of clean and safe agricultural development models. The value of agriculture, forestry, and fishery production in 2010 increased by 4% over the previous year.

Social conditions, especially level of education, have seen a significant improvement with 89.9% of high-school students graduating and the rate of poor students decreasing by 1%.

3.3 Baseline Environmental Conditions

(1) Solid Waste

According to DONRE, the total volume of solid waste generated in Dong Nai province is approximately 443,000 tons /year (equivalent to 1,215 tons/day). The rate of collection for municipal solid waste is 85.2% and the rate of collection for hazardous waste is 61%. Bien Hoa City, generates on average about 350 - 400 tons/day of municipal solid waste; including 55 tons/day of hazardous waste (Vietnam's Environmental Report in 2009).

Solid waste is disposed at the Trang Dai landfill, located at northeast edge of Bien Hoa City. The landfill site covers an area of 15 ha and is expected to be full by 2020. Dong Nai PPC has approved a new 50 ha landfill site for domestic and industrial solid waste, located in Vinh Tan Commune about 20 km northeast of Bien Hoa City. Figure 3.3.1 shows the locations of Trung Dai landfill site and Vinh Tan Commune. The government has plans to develop a 400 tons/day compost plant to reduce the waste volume. Implementation of the compost facility has been suspended since June 2008 for environmental concerns.

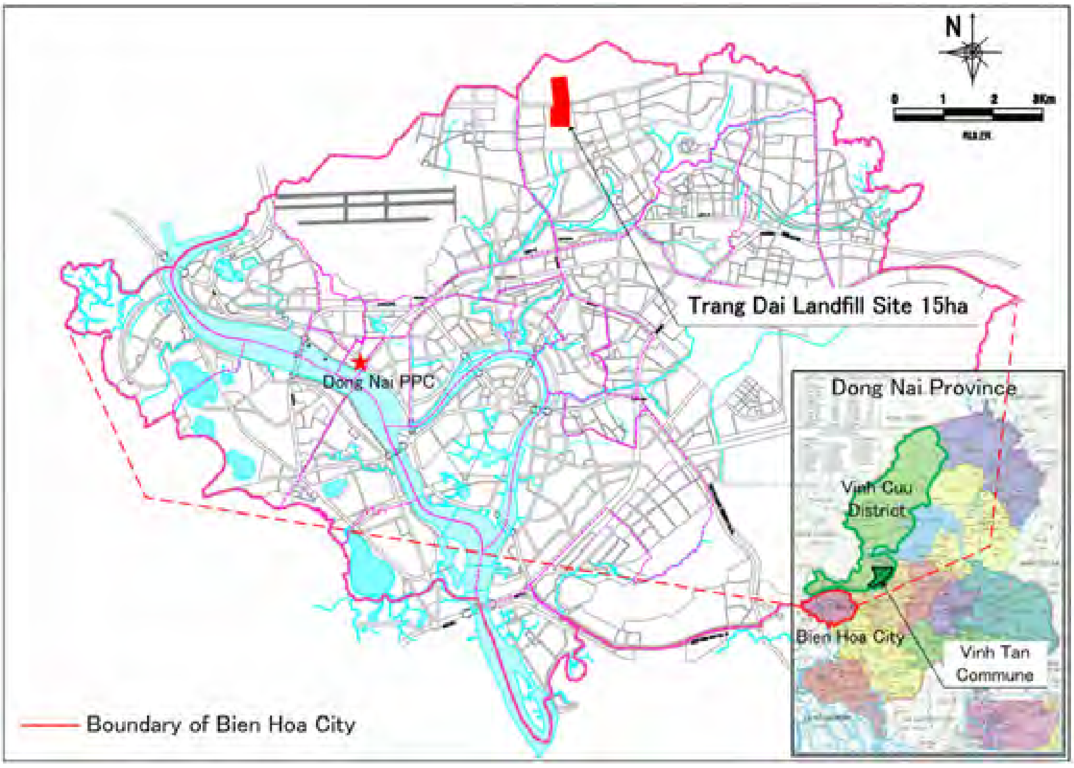


Figure 3.3.1 Location of Trang Dai Landfill Site and Vinh Tan Commune

(2) Soil Contamination

The urban area of Bien Hoa City is expanding quickly taking over agricultural land. It causes the soil contamination. Table 3.3.1 shows the monitoring result of soil contamination tests in Bien Hoa City in 2008 as reported in the current EIA. Permissible limits identified in Vietnamese standard QCVN No. 03-2008-BTNMT are also shown in the table. Arsenic, mercury and Chromium are below instrument detection limits.

Table 3.3.1 Monitoring Results of Soil Contamination

No.	Substance	Unit	Monitoring Results					QCVN 03:2008 /BTNMT
			Ho Nai ward	Tam Hiep ward	Trang Dai ward	Tan Hoa ward	Thong Nhat ward	
1	As	mg/kg	ND	ND	ND	ND	ND	12
2	Cd	mg/kg	0.12	0.14	0.12	0.15	0.14	5
3	Cu	mg/kg	3.51	4.2	4.01	3.78	4.65	70
4	Pb	mg/kg	22	16	17	21	18	120
5	Hg	mg/kg	ND	ND	ND	ND	ND	-
6	Zn	mg/kg	92	78	88	85	76	200
7	Cr	mg/kg	ND	ND	ND	ND	ND	-

Source: Centre for Environmental Treatment Technology- Defense Ministry

(3) Bottom Sediment in Canals

Many studies of canal bottom sediment have been carried out in Bien Hoa City. Table 3.3.2 shows the monitoring result of bottom sediment in Bien Hoa City in 2008. Permissible limits identified in the Vietnamese standard QCVN No. 03-2008-BTNMT are also shown in the table.

Table 3.3.2 Monitoring Results of Bottom Sediment

No.	Substance	Unit	Monitoring Results							QCVN 03:2008 /BTNMT
			San Mau stream	Linh stream	Lung ditch	Bien Hung ditch	Dien Hong ditch	Ong Gia stream	Tan Mai stream	
1	As	mg/kg	ND	ND	ND	ND	ND	ND	ND	12
2	Cd	mg/kg	0.1	0.28	0.12	0.33	0.1	0.15	0.38	5
3	Cu	mg/kg	3.24	6.95	2.57	8.95	6.27	3.54	1.32	70
4	Pb	mg/kg	1.32	4.71	1.38	7.87	3.94	1.55	1.28	120
5	Hg	mg/kg	ND	ND	ND	ND	ND	ND	ND	-
6	Zn	mg/kg	32.6	18.2	28.2	22.6	25.5	26.8	23.7	200

Source: Centre for Environmental Treatment Technology- Defense Ministry

(4) Ground Subsidence

There are no reported problems with ground subsidence in the study area.

(5) Air Pollution

Air pollution is increasing because of urbanization and the concentration of industrial parks in Dong Nai province. Air quality monitoring is carried out by the Centre for Environmental Treatment Technology, Defense Ministry. Table 3.3.3 shows the monitoring results for Bien Hoa City in 2008 as reported in current EIA. Permissible limits identified in the relevant Vietnamese standard QCVN No. 05-2009-BTNMT are also shown in the table. The only parameter that exceeds permissible limits is suspended dust.

Table 3.3.3 Monitoring Results for Air Quality

No.	Parameter	Unit	Monitoring Results					QCVN 05:2009 /BTNMT
			Ho Nai ward	Tam Hiep ward	Trang Dai ward	Thanh Binh ward	Hanoi Highway	
1	Suspended dust	mg/m^3	0.27	0.22	0.2	0.12	0.35	0.20
2	CO	mg/m^3	3.45	2.3	2.3	1.15	6.9	5.0
3	SO_2	mg/m^3	0.057	0.046	0.044	0.032	0.094	0.125
4	NO_2	mg/m^3	0.041	0.036	0.030	0.021	0.080	0.1

Source: Centre for Environmental Treatment Technology- Defense Ministry

(6) Noise and Vibration

Noise pollution is increasing because of urbanization and the concentration of industrial parks in Dong Nai province. Noise monitoring is carried out by the Centre for Environmental Treatment Technology, Defense Ministry. Table 3.3.4 shows the monitoring result for noise levels in Bien Hoa City in 2008 as reported in the current EIA. Noise in the residential areas had an average magnitude of 54 to 70 dBA . Although noise levels currently meet the limits identified in QCVN No. 09-2009-BTNMT they are near the acceptable limits.

Table 3.3.4 Monitoring Results of Noise

Parameter	Unit	Monitoring Results					QCVN 09:2005 /BTNMT
		Ho Nai ward	Tam Hiep ward	Trang Dai ward	Tan Hoa ward	Thong Nhat ward	
Noise	dBA	64 to 67	62 to 65	60 to 63	54 to 57	66 to 70	55 to 70

Source: Centre for Environmental Treatment Technology- Defense Ministry

(7) Flora, Fauna and Biodiversity

The inventory of flora, fauna and biodiversity taken from data reported in the current EIA document is as follows: Plankton Faunas have 12 species; Bottom Creatures have 37 species; Plankton Floras have 22 species in Dong Nai River.

(8) Landscape

Urbanization is changing the natural landscape. Many residential and commercial building are being constructed along major arterial roads. Newly constructed building tends to be concrete multi-story, narrow and tightly packed to save space. There is no architectural consistency. Older dwellings in the back lanes tend to be smaller single story units. There are many pockets of informal dwelling along the drains. The area around the STP and PS facilities is populated by older and in some cases informal dwellings.

3.4 Existing Drainage/Sewerage System

The current sewerage system in Bien Hoa City is basically a combined system. This means that sewage, normally effluent from septic tanks, kitchen, and bath room, and storm water, are collected and conveyed in the same sewer.

There is no sewage treatment system for residential areas. Wastewater is only partially treated through septic tanks, then discharged to sewers or soak away pits or directly into surface water drains. However, these septic tanks are not cleaned regularly causing poor quality of treated water, fouling of storm water drains and pollution in the Dong Nai River.

The JICA Study Team conducted a questionnaire survey of 380 households in the proposed project area in December, 2010 to identify awareness of sanitary conditions and to determine willingness to pay for future connection to the public sewer. The survey results presented in Table 3.4.1 indicate that the majority of the households have septic tanks and most of them appear to be connected to the public storm water sewer or combined sewer where it exists.

Table 3.4.1 Survey Results on the Ratio of Septic Tank Installation and Connection to Public Sewer at the Center of Bien Hoa City

Item	Ratio (%)
Houses installing Septic Tank	96.9%
Septic tank connection Public Sewer	70.9%

The drainage network was built during the French Colonial rule and American occupation period, and has been partially rehabilitated since 1975. Records for 1993 indicate that there was 14,200 m of sewers and drains in the whole of Bien Hoa City:

- Sewers with diameter 600 mm to 800 mm : 5,000m
- Slab drains with width 400 mm to 600 mm : 9,200m

From 1993 to present, the city has carried out rehabilitation and new construction of sewers, box culverts, and drains to mitigate local flooding (for example, Bien Hung park area) and improvement and construction of sewers and drains have been made together with road rehabilitation and construction. The existing sewers and drains are approximately 62 km as of 2010 as shown in Figure 3.4.1 and Table 3.4.2. The Urban Environment Company (URENCO) is responsible for maintenance of drainage and sewerage systems.

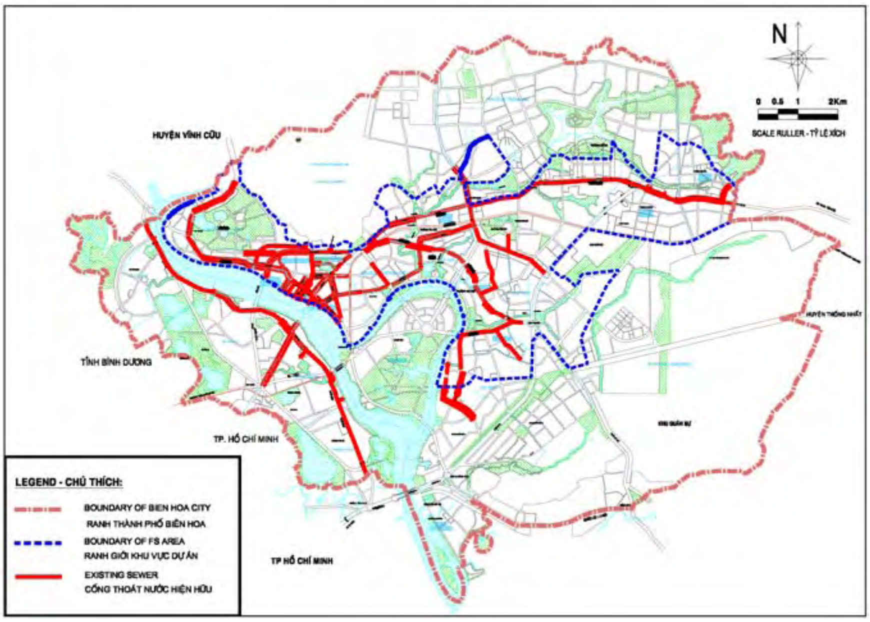


Figure 3.4.1 Existing Drainage/Sewerage System in Bien Hoa

Table 3.4.2 Existing Drainage/Sewerage Facilities in Bien Hoa

No.	Items	Unit	Quantity
I	Covered channel, Box culvert		
1	Covered channel 400 × 600	m	4,536
2	Covered channel 500 × 750	m	8,447
3	Covered channel 600 × 750	m	309
4	Covered channel 600 × 800	m	1,968
5	Box culvert 800 × 800	m	488
6	Box culvert 1000 ×1000	m	3,400
7	Box culvert 3000 ×3000	m	3,080
Sub-total			22,228
II	Circular pipe		
1	DN 400	m	2,188
2	DN 600	m	2,980
3	DN 800	m	28,502
4	DN 1000	m	4,469
5	DN 1200	m	1,570
Sub-total			39,709
Total			61,937

Source: FS Report

All industrial parks in Bien Hoa City have their own sewerage systems. Bien Hoa II industrial park has a sewage treatment plant (STP) with a design capacity of 8,000m^3/day, and a current flow of 4,000m^3/day. Loteco and Amada industrial parks also have STPs with capacity of 2,000m^3/day and 1,000m^3/day respectively. Figure 3.4.2 shows the location of industrial parks. Treated methods of industrial parks are described in Appendix 3-B.

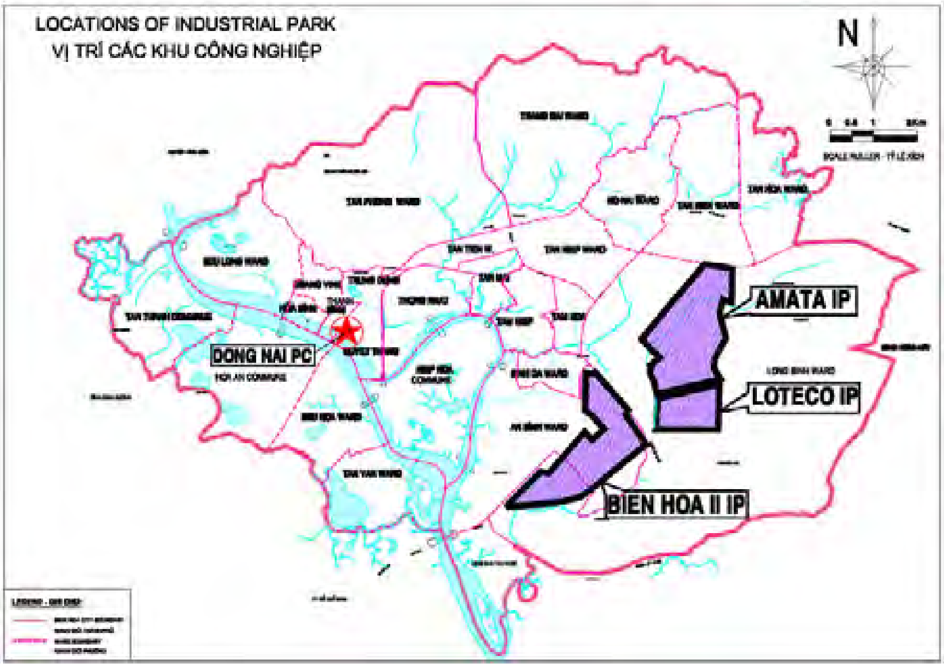


Figure 3.4.2 Locations of Industrial Parks

3.5 Existing Canals

The location of canals is shown in Figure 1.2.3 and Table 1.2.8 of the previous Chapter. The water in canals is highly polluted and has the same characteristics as raw wastewater.

Table 3.5.1 Water Qualities in Canals of Bien Hoa City

	BOD, mg/l	COD, mg/l	NH_3-N, mg/l	Coliform, MPN/100ml
San Mau Stream[1)]	74 - 257	184 - 456	16 - 48	5,232,500 – 30,075,000
Linh Stream[1)]	272 - 693	502 - 1,382	16 - 48	13,423,250 – 59,875,000
Raw Sewage[2)]	110 - 350	250 - 800	12 - 45	1,000,000 – 10,000,000,000

Source: 1) DONRE
2) Metcaf & Eddy, Wastewater Engineering 4th Ed., p186

3.6 Waterborne Diseases

Table 3.6.1 shows the number of water-borne diseases reported in Bien Hoa City. There is no evidence to support a direct relationship between water quality and these diseases. However, it is highly likely that a large part of these is due to polluted water.

Table 3.6.1 Number of patient of Waterborne Diseases

Year	Unit	Dysenteric Diarrheas	Dysentery
2007	Person	1,719	108
2008	Person	1,810	125
2009	Person	2,524	129

Source: Sewerage PMU

3.7 Need for the Project

3.7.1 National Policy and Sector Program

Since the Project covers the major urban center and growing area of Bien Hoa City and includes drainage and sewerage provisions mentioned in the previous section, the Project complies with the national policy on water sector described in Chapter 2.

3.7.2 Present and Future Demand of Drainage and Sewerage System in the Study Area

(1) Sewerage and Sewage Treatment

There is no sewage treatment facility therefore wastewater is discharged directly to the Dong Nai River untreated. Bien Hoa City is located just upstream of the water supply intake for Ho Chi Min City.

Most households dispose of their wastewater to septic tanks. Septic tank effluent which does not meet water quality standards is discharged to canals. As a result most of the surface water in Bien Hoa is highly polluted.

The total population in Bien Hoa City is expected to expand by about 180,000 between 2010 and 2020 to reach 830,000. The annual growth rate of 2.5% is moderate but reflects continued rapid urbanization.

So far the consequences are not too severe but serious water and sanitation-related public health problems are likely to occur if wastewater pollution is not prevented. There is therefore an urgent need for action to improve sewerage services in Bien Hoa City to meet the basic needs of its growing population, to improve water quality and public health, and to allow commercial development. The proposed project includes the construction of separate sewage collection and central treatment plant. The project is the first in a series of investments that will be required to meet the long-term needs for wastewater disposal.

(2) Drainage

Localized flooding frequently occurs when there is heavy rainfall. The problem in some areas is aggravated by the influence of high tides on river water levels. Flooding damages properties resulting in economic losses. Flooding also affects the flow of traffic. Flood water is a mix of raw sewage and urban runoff that is very unsanitary and presents a risk to public health. Poor drainage can also lead to problems with odor, mosquitoes and fly breading which can have an impact on public health.

Parts of the City that are frequently flooded are:

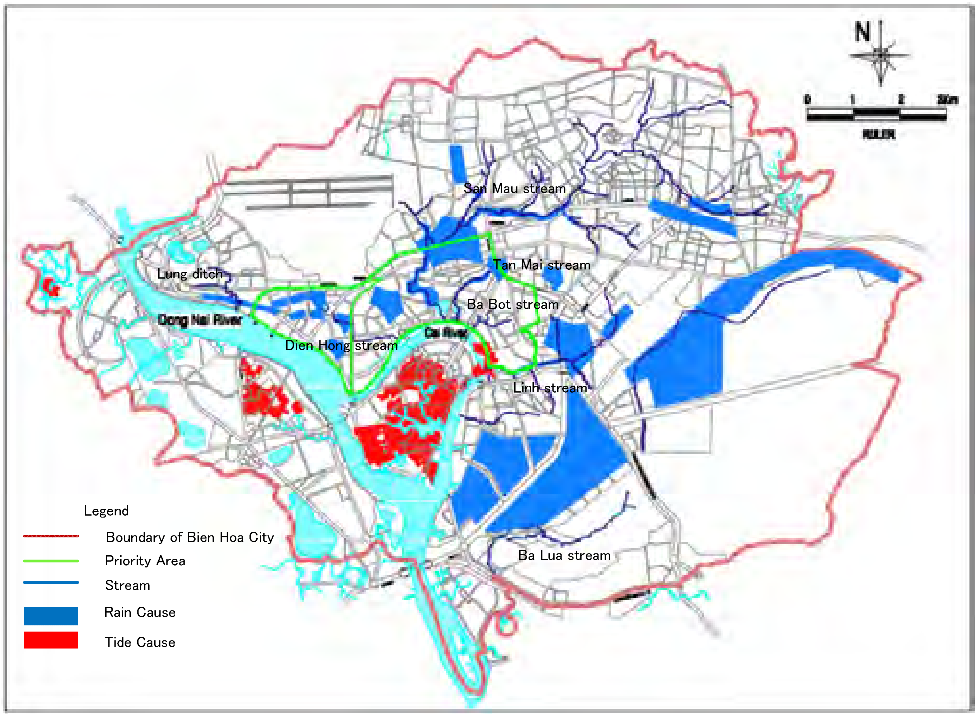
- Residential area near the Psychiatry hospital
- Area in front of Tan Hiep bridge (flood depth: 0.3 – 0.7m)

- Basin of San Mau stream (flood depth: 0.5 – 1.0m)
- Area in Tan Mai stream (flood depth: 1.5m)
- Area in Linh stream (flood depth: 1.0 – 2.0m), and
- Area in Ba Lua stream to National highway No.51 (flood depth: 0.5m).

Flooding locations are shown in Figure 3.7.1. Areas highlighted in blue are flooded as a result of poor drainage. Areas in red are affected by high tides.

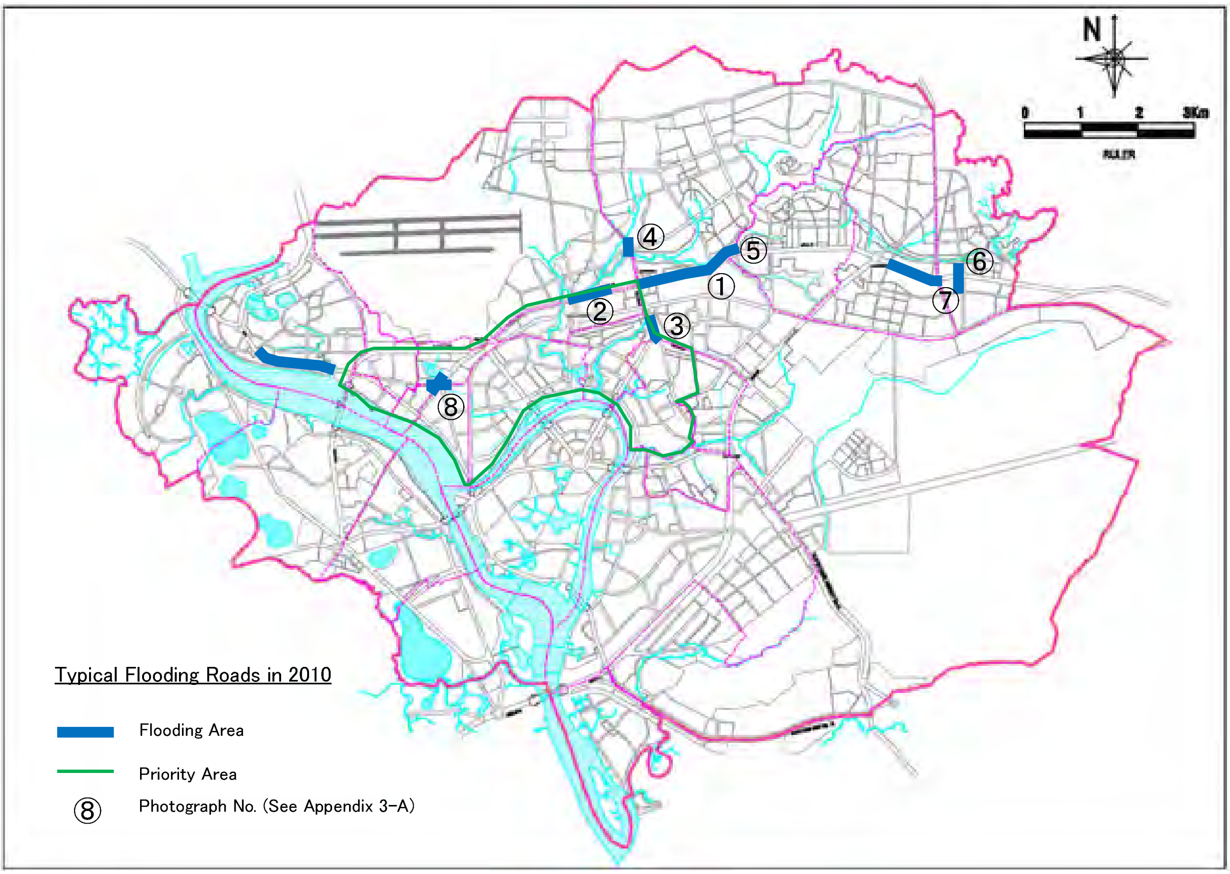
Figure 3.7.2 shows the roads that where affected by flooding that occurred in 2010.

The Flood records, such as rainfall volumes, addresses of flooding areas and photographs in 2010 are attached in appendix 3-A.



Source: PMU

Figure 3.7.1 Frequent Flood Affected Area



Source: PMU

Figure 3.7.2 Flood/Inundation Affected Roads in 2010

The accumulation of garbage and sediment in surface drains greatly reduces flow capacity. In other cases development has encroached on drains reducing the cross section. Continued urbanization will result in more impervious surfaces creating even more surface water thereby increasing the size and frequency of floods. There is therefore an urgent need to improve drainage in Bien Hoa City to mitigate future flood damages, improve living conditions and reduce the risk to public health.

3.8 Proposed Project

Based on the needs identified in the priority area the JICA Study Team recommends a project with the following main components:

- Construction of interceptor sewers and additional combined sewer in combined sewer area
- Construction of sanitary sewers and storm sewers in separated sewer area
- Construction of Intermediate pumping stations
- Construction of STP
- Improvement of canals

Table 3.8.1 presents project components in the priority area (Scope of the Priority Project I). Almost all the components were identified in the Phase I Study. The JICA Study team has added bank protection works for Linh Stream to the scope of work because Linh stream is the discharging body of the proposed STP2 and must function reliably as the outlet from the STP.

Table 3.8.1 Proposed Project Components

Components	Unit	Quantity	Remarks
STP2	m^3/d	41,500	Tam Hiep Ward
Pumping Station	places	2	Thong Nhat Ward, STP2 Site
Manhole Type Pump Station	places	25	
Sewerage Facilities			
Main Trunk Sewer	km	12	D 200mm – 1500 mm
Branch Sewer	km	42	D 200mm – 280 mm
Tertiary Sewer	km	203	D 200mm
Interceptor pipe	km	6	D 100mm – 900 mm
Drainage Facilities			
Main Storm Sewer for Separate Area	km	45	D 600mm – 2000 mm, B 3000mm x H 3000mm
Main Storm Sewer for Combined Area	km	10	D 600mm – 2000 mm, B 2000mm x H 2000mm
Brunch Storm Sewer	km	111	D 500mm
Canal Improvement			
2.1 Bien Hung ditch with Gate	m	2,160	
3.2 Dien Hong ditch	m	370	
4.1 San Mau stream	m	3,650	
4.2 San Mau stream	m	2,480	
4.3 San Mau stream	m	390	
4.4 San Mau stream	m	610	
4.5 San Mau stream	m	1,310	
4.6 San Mau stream	m	720	
5.1 Linh Bayou	m	1,060	
6.1 Linh Bayou	m	1,150	
Linh Stream	m	1,150	
Procurement of O&M equipment	LS	1	High-Velocity Jet Truck, Vacuum Truck etc.

D: Diameter, B: Width, H: Height

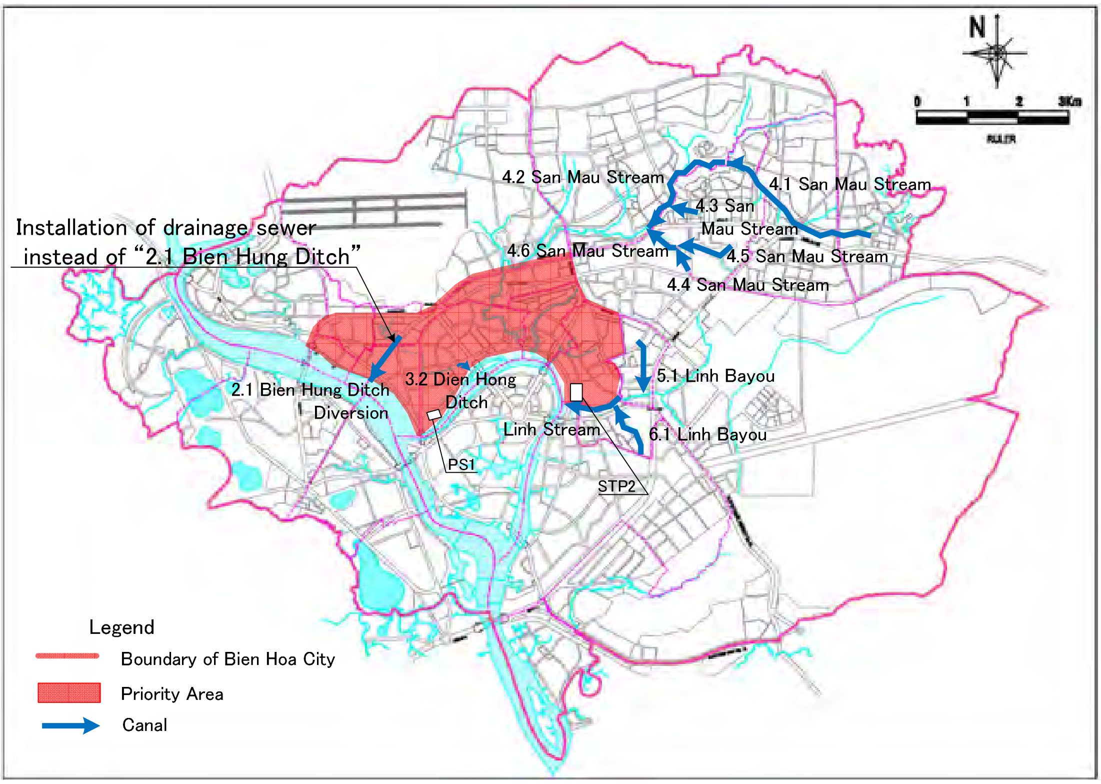


Figure 3.8.1 Proposed Project Components

CHAPTER 4 PLANNING FRAMEWORK FOR SEWERAGE AND DRAINAGE SYSTEMS

The Priority Area for sewerage development and the list of canals to be improved were identified in the Preparatory Study for Dong Nai Water Environmental Improvement Project in June, 2010 (Phase I Study conducted by JICA). The details are explained in Section 1.2.4, Chapter 1 of this report.

4.1 Planning Horizon and Design Capacities

The study has adopted the following planning horizons for determining design capacities:

- 2020 for the treatment plant and pumping stations and
- 2030 and trunk sewers including interceptor.

The selected planning horizons are consistent with Article 13 of Vietnamese DECREE 88 on Drainage and Sewerage for Urban Areas and Industrial Zones dated 28 May, 2007 which states that “Drainage/sewerage plans shall be prepared for short-term phases of 10 years; long-term phases of 20 years and longer.

In industrialized countries it is common to design treatment facilities, pumping stations, and rising mains upon the demand of the next 10 to 20 years. Trunk sewers have a much longer service life and are normally designed for a longer life.

In selecting the design capacities it is important to consider the relatively dynamic and unpredictable nature of growth in the Bien Hoa City.

It is more prudent to design treatment and pumping capacity for a rather shorter horizon of 2020. Periodical extensions of pumping station and treatment capacity would then follow, always adapted to the observed increase of demand and experience gained through operation of the first phase facilities.

Design capacity of trunk sewers should be based on flows for 2030 because these cannot be upgraded.

4.2 Target Service Area

The size and limits of the urban area identified in previous plans and studies are shown in Figure 4.2.1 and Table 4.2.1. The urban area identified in the Approved General Plan is smaller than the City limits because it excludes forests and large parcels of land used for security and military operations and agriculture.

Table 4.2.1 Urban Areas Identified for Sewerage and Drainage Development

Item	Bien Hoa City	Urban Area in 2020 in Adjusted General Plan	F/S Area for Drainage and Sewerage development
Area (ha)	15,508 ha	9,966 ha	3,635 ha

Source: The Adjusted General Planning of Bien Hoa City up to 2020
Feasibility Study for Phase I of Sanitation and Drainage Project

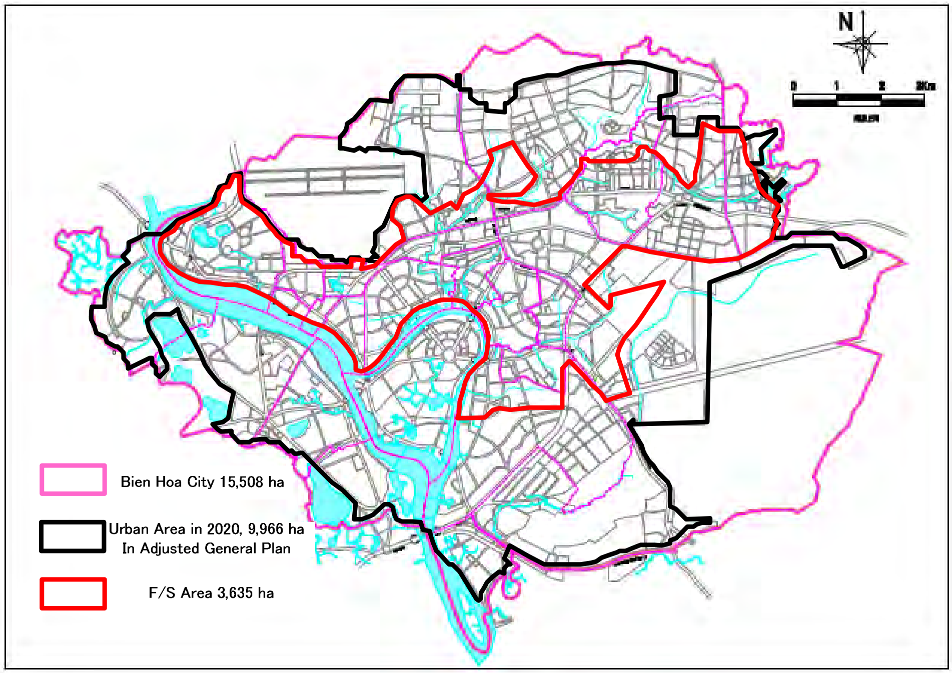


Figure 4.2.1 Urban Areas Identified in Previous Plans and Studies

Sewerage is planned for the entire urban areas designated in the Approved General Plan that do not contribute any sewage such as large parks, water surfaces, and cemeteries. This area is 6,174 ha and is referred to as the Entire Service Area.

The service area for the priority project I is 971 ha and is located within the boundaries of the previous F/S.

The Entire Service Area and the Priority Area are shown in Figure 4.2.2.

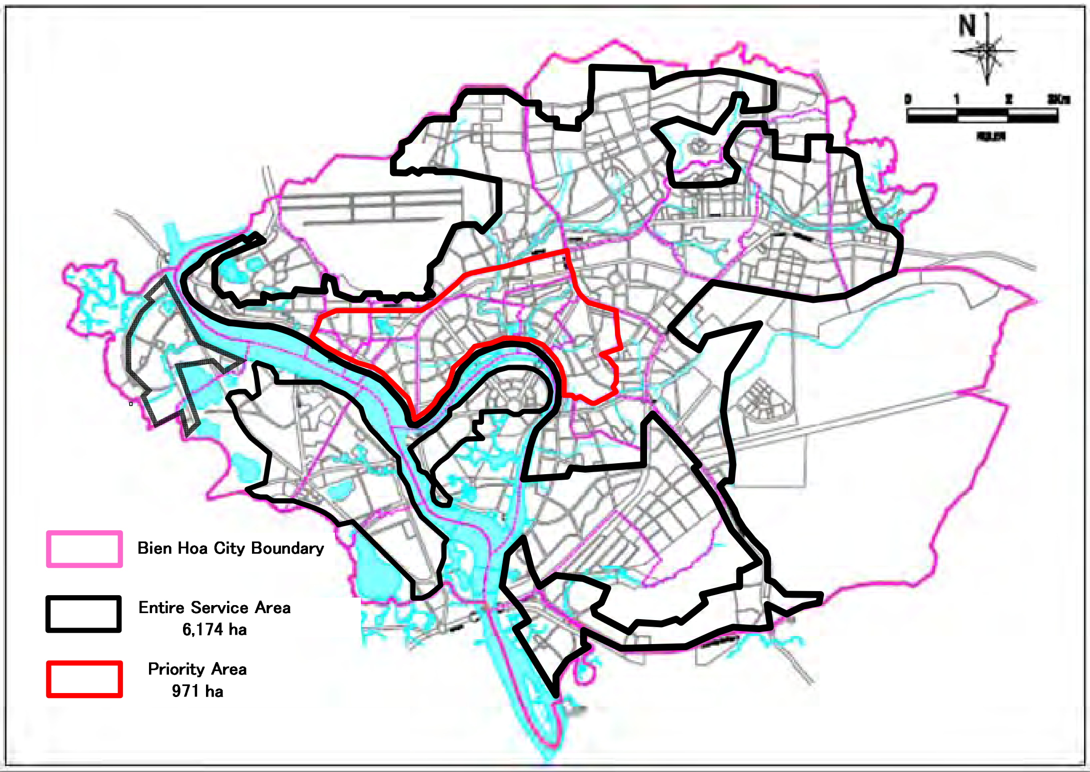


Figure 4.2.2 Sewerage and Drainage Service Areas

4.3 Sewage Collection Systems

Sewage in the priority area will be collected in pipes and conveyed to a central treatment plant (STP2). Sewage outside the priority area will continue to be discharged to septic tanks with effluent connections to storm water drains.

Sewage collection systems can be either combined or separate. Combined sewers carry both storm water and sewage in the same pipe, while separate sewers carry storm water and sewage in separate pipes. In dry weather the flow, which is mostly sewage, is diverted into an interceptor sewer and conveyed to the treatment plant. In wet weather some of the flow gets diverted to the treatment plant however flows in excess of interceptor capacity are diverted to the River.

In separate systems storm water does not mix with sewage. Sewage is conveyed to the STP through separate trunk sewers and pumping stations. In practice there is usually ingress of storm water into sewage pipes, because of unsealed pipe joints, and unintentional or illegal connections of rainwater runoff.

A comparison of the two types of sewage collection systems is presented in Table 4.3.1. The development of separate sewerage systems is usually preferred because storm water is generally less polluted than sewage and the treatment of combined sewage and storm water is difficult during heavy rainfalls, resulting in untreated overflows and treatment plant upsets. Separate sewer systems have many advantages and are recommended by the Study Team for the priority project I however they are more costly to construct.

Table 4.3.1 Comparison of Sewage Collection Systems

Item		Combined system		Separate system	
Maintenance & Operation	Existing Sanitary facility (Septic Tank)	- Need to de-sludge once every two years	×	- No need to de-sludge	○
	Collection System (sewer)	- In dry season, sediment settles in pipe - In wet season, sediment in pipe is flushed out and overflows into public water body	△	- It is possible to collect all sewage if households connect to the new sewer	○
	STP	- Inflow increases during wet weather potentially leading to process upsets	△	- flows are more steady and sewage strength more stable	○
Collecting/increasing Sewage Tariff		- The residents' incentive for payment of Sewage tariff is low because there is no perceived improvement in sanitary conditions.	△	- benefits of connecting are tangible therefore easier to justify a sewage tariff	○
Improvement of Living condition		- Maintenance of septic tank is still required. - Vacuum tanker for sludge removal from septic tank moves around the town with odour	×	- Living conditions can be improved if resident do not have a septic tank	△
Effect of Water Environment Improvement in public water body	Intake of water supply	- Some influences	△	- No influence	－
	Rivers and Lakes	- Combined flow including sewage is flowing into public water bodies	△	- Sewage is treated before discharging public water bodies	○
Basic Construction Cost of Sewerage System		- Construction cost of pipeline is cheaper than separate system due to short length of proposed pipe	○	- Construction Cost is much higher than combined system, as both sanitary and drainage sewers are installed.	△
Necessity of upgrading sewerage system in future (investment to new facilities)		- Change to separate system is required in the future	△	- No need for future investment	○

Bien Hoa City has a combined sewer system serving 4 wards located in the older center core (Thanh Binh, Hoa Binh, and Quyet Thang ward and a part of Quang Vinh and Trung Dung ward). It covers a relatively small area of 272 ha. As outlined in the F/S report the priority project I will not provide separate sewers in this area for the following reasons:

- Existing combined sewers provide relatively good coverage in terms of density and capacity as shown in Figure 3.4.1 and only a few sewers need to be replaced to increase their capacity to handle storm water runoff.
- Construction of a separate sewer system would be costly and would cause significant disruptions to residents and traffic in the busy center of the city.

Areas outside the existing combined sewer area will be provided with a separate sewer system. The combined sewer area is shown in Figure 4.3.1.

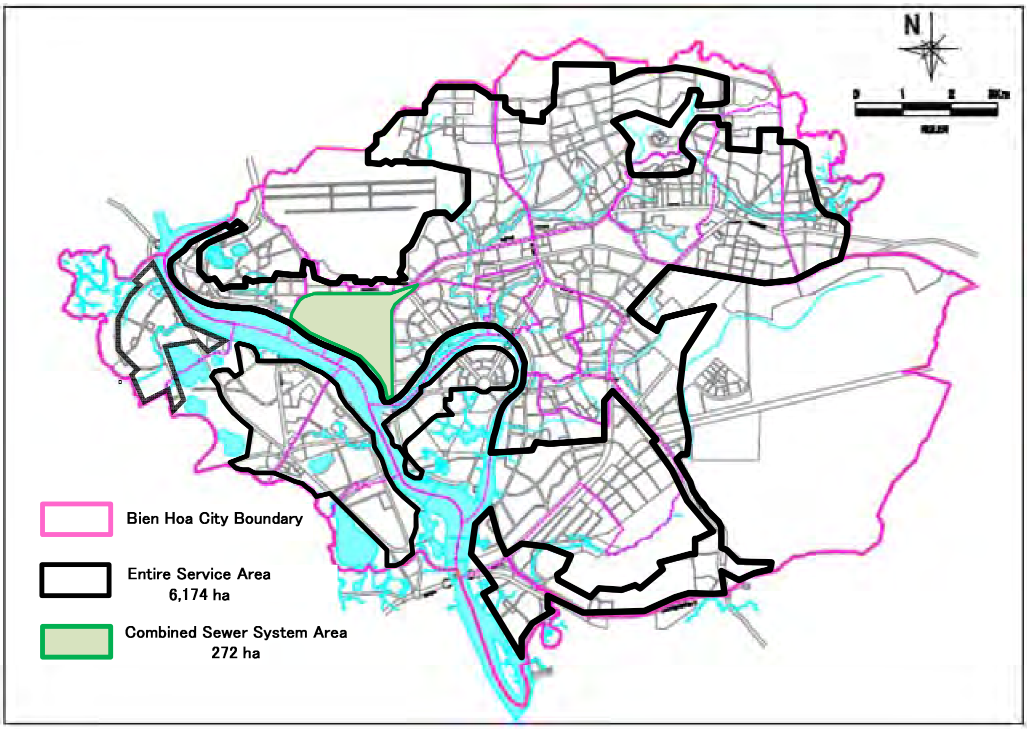


Figure 4.3.1 Location and Type of Sewage Collection System

The proposed sewage collection system is consistent with the requirements of Vietnamese regulation Item 3, Article 12 of DECREE 88 on Drainage and Sewerage for Urban Areas and Industrial Zones dated 28 May, 2007 which stipulates that "As for new urban and industrial areas, separate systems for storm water and sewage shall be developed. As for existing urban areas with existing drainage/sewerage systems, depending on local conditions, plans shall be studied and prepared for combined system, separate systems or semi-separate systems."

4.4 Population Projections

4.4.1 Population in the Urban Area

Future population projections provided in previous plans and studies are summarized in Table 4.4.1.

Table 4.4.1 Population Projections in Previous Plans and Studies

Year	2002 (Actual)	2010	2020	2030
Approved General Plan (9,966ha)	476,452	615,000	800,000	Not provided
Master Plan (9,966 ha)	-	620,000	800,000	Not provided
F/S (3,635ha)	-	420,952	Not provided	Not provided
JICA Preparatory study Phase I	-	-	800,000	800,000

Source: The Adjusted General Planning of in Bien Hoa City up to 2020
Master Plan on Sewerage and Environmental Sanitation for Urban and Industrial Zones in Area of Bien Hoa City (period 2003-2020)
Feasibility Study for Phase I of Sanitation and Drainage Project

The Phase I preparatory study has adopted the same population projection for the year 2020 and 2030, as the populations for 2020 represent conditions that population densities have reached full saturation levels identified in the Master Plan.

Population distribution by ward and corresponding population densities as defined in the F/S are shown in Table 4.4.2. The distribution is based on the Approved General Plan. Residential areas are indicated in Figure 4.4.1.

Table 4.4.2 Population Served and Population Density by Residential Area in 2020

Residential Area	Name of Ward/Commune	Population	Entire Service Area (ha)	Population Density (person/ha)
No.I	Thanh Binh, Hoa Binh, Quyet Thang, Quang Vinh, Trung Dung, Buu Long	110,000	560	196
No.II	Thong Nhat, Tan Tien, Tan Mai, Tam Hiep	125,000	699	179
No.III	Tam Hoa, Binh Da, An Binh, Long Binh Tan, Long Binh	180,000	1,260	143
No.IV	Tan Hiep, Tan Bien, Tan Hoa, Ho Nai	180,000	1,219	148
No.V	Trang Dai, Tan Phong	90,000	1,436	62.7
No.VI	Hiep Hoa	11,897	150	79.3
No.VII	Buu Hoa, Tan Van	47,586	360	132
No.VIII	Hoa An, Tan Hanh	55,517	490	113
Total		800,000	6,174	130

Source: F/S and Basic Design Report, JICA Study Team

*1 : Large parks, water surfaces and cemeteries are not included in the Areas.

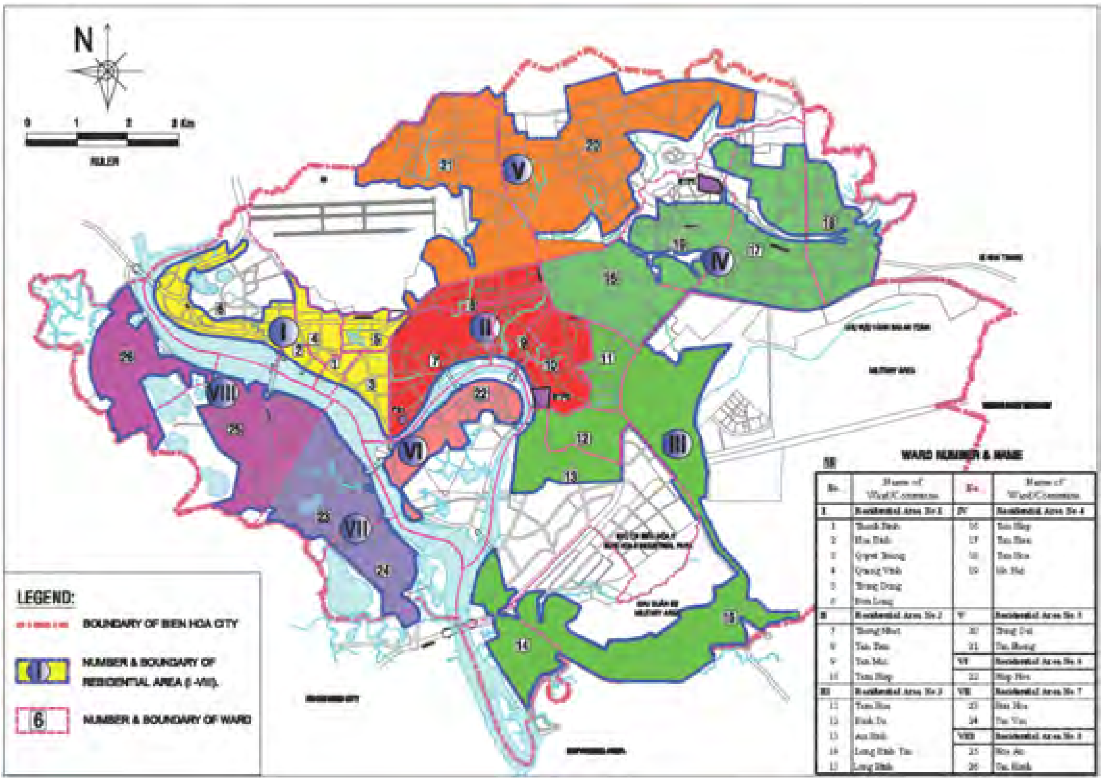


Figure 4.4.1 Delineation of Urban Residential Areas

4.4.2 Populations for the Priority Project I

The Master Plan for Sewerage has identified the need for three sewage treatment plants. Treatment plant STP2 constructed under the proposed priority project I is the largest and will initially receive flows from the priority area (residential area I and II). In accordance with the Master Plan sewage from collection systems outside the priority area (parts of area No. III, IV and V) would also be conveyed to STP2. Therefore trunk sewers in the priority project I are sized to accommodate these future flows.

A breakdown of the catchment areas and populations allocated to each treatment plant is shown in Table 4.4.3. The breakdown of the catchment areas are indicated in Figure 4.4.2.

Table 4.4.3 Treatment Plant Catchment Areas and Populations

Residential Area	Sub-Area	Area (ha)	Population Density (person/ha)	Serviced Population 2030 (person)			
				STP1	STP2	STP3	Priority Area
No.I	1	560	196				
	1.1	272	233		63,269		63,269
	1.2	76	233		17,678		
	1.3	212	137		29,053		
No.II	2	699	179		125,000		125,000
No.III	3	1,260	143				
	3.1	691	143		98,714		
	3.2	569	143			81,286	
No.IV	4	1,219	148				
	4.1	643	148		55,869		
	4.2	576	148	124,131			
No.V	5	1,436	62.7		90,000		
No.VI	6	150	79.3			11,897	
No.VII	7	360	132			47,586	
No.VIII	8	490	113			55,517	
Total		6,174	130	124,131	479,583	196,286	188,269
				800,000			

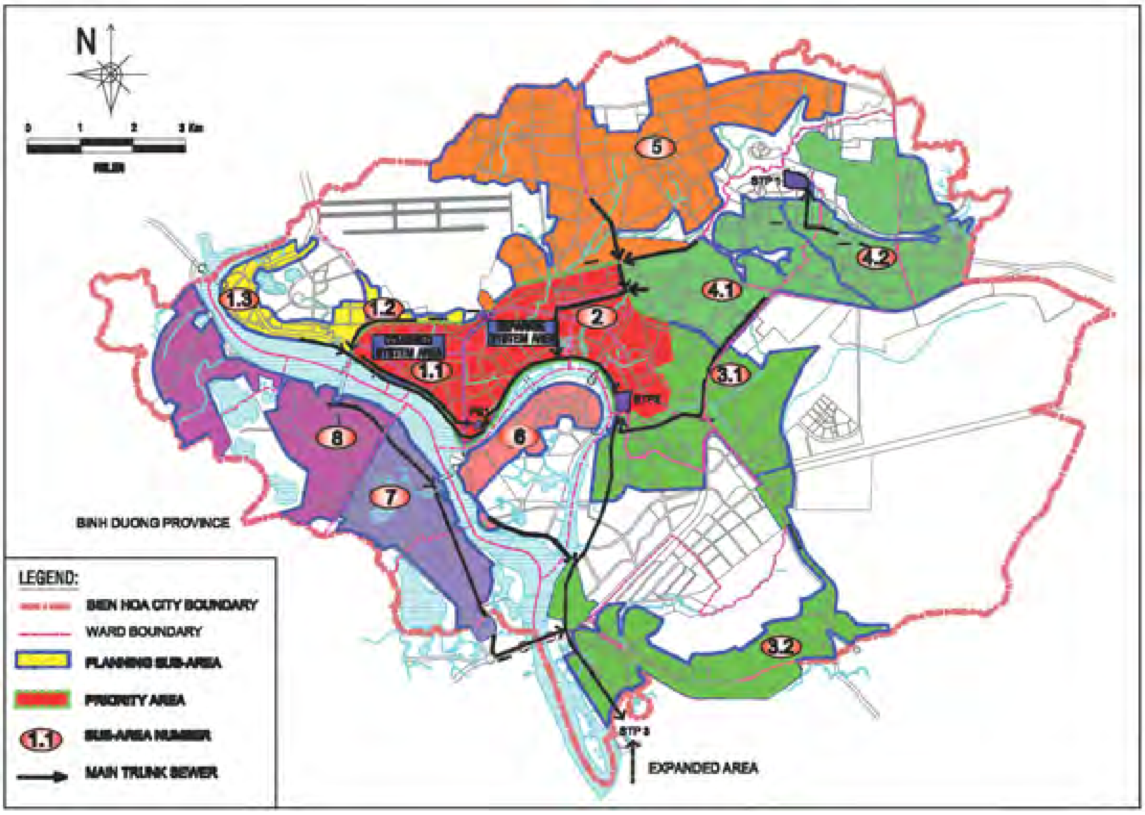


Figure 4.4.2 Sub Areas of Urban Residential Areas

Populations used for planning in this study are summarized in Table 4.4.4.

Table 4.4.4 Served Population (person)

Item	Entire Service Area				Priority Project I Area
	STP 1	STP 2	STP 3	Total	
Sewerage Served Population	124,131	479,583	196,286	800,000	188,000

4.5 Design Sewage Flow and Strength

4.5.1 Design Sewage Flow

(1) Unit Water Consumption

Sewage flow is a function of water consumption. Domestic unit water consumption rates obtained from previous plans and studies and those identified in the design standard for water supply systems (TCXDVN 33-2006) issued by MOC are summarized in Table 4.5.1.

Table 4.5.1 Unit Water Consumptions in Previous Plans and MOC Standard

(Unit: l/capita/day)

Year	Actual average 2009	Approved General Plan	Master Plan	F/S	MOC Standard
2010	63	150	150	150	120
2020	-	165	165	165	150

MOC Standards for calculating water demand are presented in Table 4.5.2.

Table 4.5.2 Design Standards for Water Supply Systems

Subject Use the Clean Water	Stage	
	2010	2020
Urban level 2,3		
a) Domestic water		
Water supply standard (l/capita/day)		
Internal Urban	120	150
External Urban	80	100
Service Ratio (%)		
Internal Urban	85	99
External Urban	75	90
b) Public Service Water (water for tree, clean road, fire system)		
b) = a) × following percentage (%)	10	10
c) Commercial and Urban Service Water	10	10
d) Industrial Water (m^3/ha/day)	22-45	22-45
e) Leakage Water		
e) = (a+b+c+d) × following percentage (%)	<25	<20
f) Water Treatment Plant Service Water		
f) = (a+b+c+d+e) × following percentage (%)	8-10	7-8

Source: TCXDVN 33-2006, MOC

Metered water consumption presented in Table 4.5.3 indicates that the average water consumption is actually much lower than the values prescribed for planning and design.

Table 4.5.3 Water Consumptions from March 2009 to February 2010

No.	Wards/Communes	Water Consumption (m^3/year)	Serviced Population	Water Consumption (l/capita/day)
1	Thanh Binh	332,920	5,034	181
2	Quyet Thang	947,546	15,426	168
3	Hoa Binh	437,506	7,910	152
4	Quang Vinh	812,492	15,371	145
5	Trung Dung	921,484	17,791	142
6	Buu Long	1,218,825	25,579	131
7	Tan Tien	627,119	14,887	115
8	Thong Nhat	922,587	23,615	107
9	Tam Hoa	582,162	16,221	98
10	Tan Mai	688,879	20,096	94
11	Buu Hoa	657,356	19,489	92
12	Binh Đa	494,807	18,286	74
13	Hoa An	693,518	27,084	70
14	An Binh	971,854	43,837	61
15	Tan Hiep	638,537	29,986	58
16	Tam Hiep	706,222	33,396	58
17	Tan Phong	880,687	41,881	58
18	Hiep Hoa	213,947	12,725	46
19	Tan Hanh	129,180	8,488	42
20	Ho Nai	448,638	31,961	38
21	Long Binh	678,523	74,474	25
22	Tan Bien	333,428	36,771	25
23	Tan Vạn	73,786	13,982	14
24	Trang Dai	228,072	55,199	11
25	Long Binh Tan	108,840	45,313	7
26	Tan Hoa	N/A	38,091	N/A
	Total/Average	14,748,915	692,893	63

Source: Water Supply Company and JICA Study Team

On the other hand, per unit consumption in the priority area is relatively high with maximum of 181 l/capita/day and average of 126 l/capita/day (Refer to Table 4.5.4).

Table 4.5.4 Water Consumptions from March 2009 to February 2010 in Priority Area

No.	Wards/Communes	Water Consumption (m^3/year)	Serviced Population (person)	Water Consumption (l/capita/day)
1	Thanh Binh	332,920	5,034	181
2	Quyet Thang	947,546	15,426	168
3	Hoa Binh	437,506	7,910	152
4	Quang Vinh	812,492	15,371	145
5	Trung Dung	921,484	17,791	142
7	Tan Tien	627,119	14,887	115
8	Thong Nhat	922,587	23,615	107
9	Tam Hoa	582,162	16,221	98
10	Tan Mai	688,879	20,096	94
Total		6,272,695	136,351	126.04

Source: Water Supply Company and JICA Study Team

The Study Team concludes that the unit consumption rate of 165 lpcd is suitable for calculating sewage quantities generated inside the priority area. However a lower value of 150 lpcd is recommended for estimating sewage quantities in service areas outside the priority area because per capita consumption is still rather low and not likely to increase much by 2020.

Unit water consumption rates used for calculating sewage flows for the priority project I are summarized in Table 4.5.5.

Table 4.5.5 Unit Water Consumptions for Sewage Estimation

(Unit: l/capita/day)

Year	Entire Sewerage Serviced Area (9,966 ha)	Priority Area (1,072 ha)
2010 (present record)	63	126
2020	150	165
2030	165	165

(2) Sewage Production and Average Daily Flow

Sewage production is a function of the water that is consumed however not all water is returned as sewage. Some portion will be consumed for drinking and cooking or may be used for watering gardens or washing cars. The sewage return factor generally ranges between 0.70 and 0.85. Higher return factors are typical for low to middle income households or high density urban areas whereas lower return factors are typical for high income households or lower density sub-urban areas with larger plots. The return factor assumed for the project is 0.80.

The amount of sewage actually collected and conveyed to the treatment plant will also depend on how many households connect to the sewer system. The project assumes a 100% connection rate based on the fact that 100% of the households in the priority area have a water supply connection.

The unit consumption rates for water include all uses but, in accordance with the Master Plan and F/S, an additional 10% is included for contributions from public service activities and small industries that may have their own private water supply systems.

Calculations for the amount of sewage collected must also include a factor for the groundwater and surface water that enters the system at pipe joints and manholes. A factor of 10% has been added to the total projected flow in separate sewer areas. The factor reflects relatively high groundwater tables and poor surface drainage.

The calculation of daily average flows to each STP for the year 2020 and 2030 is presented in Table 4.5.6.

Table 4.5.6 Daily Average Flow by STP in 2030 and STP 2 in 2020

Items	unit/ratio	2030				2020 (Priority Area)	
		STP1	STP2		STP3	STP2	
		Separate	Combined	Separate	Separate	Combined	Separate
Population	person	124,131	63,269	416,314	196,286	63,269	125,000
Water Consumption	m^3/capita/day	165	165	165	165	165	165
Return Factor	%	80	80	80	80	80	80
House Connection Ratio	%	100	100	100	100	100	100
Domestic Sewage Flow	m^3/day	16,385	8,352	54,953	25,910	8,352	16,500
Infiltration Ratio	m^3/day (10%)	1,639	-	5,495	2,591	-	1,650
Public Service Ratio	m^3/day (10%)	1,639	835	5,495	2,591	835	1,650
Small Industry	m^3/day (10%)	1,639	835	5,495	2,591	835	1,650
Storm Water Flow(1)	m^3/day	-	10,022	-	-	10,022	-
Total wet weather flow	m^3/day	21,301	20,044	71,438	33,683	20,044	21,450
Grand Total	m^3/day	21,301	91,482		33,683	41,494	
Rounded Wet Weather Flow	m^3/day	21,300	91,500		33,700	41,500	
Planned (Design) Capacity	m^3/day	21,300	52,000(2)		73,200(3)	41,500	

Notes: (1): Based on interceptor capacity of 2 × dry weather flow.
(2): Capacity identified in Master Plan and approved EIA.
(3): Excess flow of 39,500 m^3/d transferred from STP 2.

The capacity of STP2 identified in the Master Plan and approved in the EIA is 52,000 m^3/day. Sewage inflow to STP2 in excess of 52,000 m^3/day would be conveyed to STP3 as shown in Table 4.5.6. The design average flow for STP 2 in 2020 is 41,500 m^3/day.

(3) Peak Factors

Sewage flow is not constant and fluctuates throughout the day following a diurnal pattern. Therefore, sewerage facilities must be designed to handle peak flows to prevent operational difficulties such as overflow from sewers, or poor treatment performance. Peak factors selected for the design of sewerage facilities are based on the Vietnamese “Design Standard TCVN 7957:2008” and are described below.

- **Sewer and Pump Station**

Table 4.5.7 Peaking Factor (Kc)

	Average Sewage Flow (l/sec)								
	5	10	20	50	100	300	500	1000	>=5000
Peaking Factor	2.5	2.1	1.9	1.7	1.6	1.55	1.5	1.47	1.44

Source: Design Standard TCVN 7957:2008

- **Interceptor Sewers**

In a combined system, interceptor sewers control the flow of sewage to the treatment plant. In a storm, they allow some of the storm water (usually the polluted first flush) to flow to the treatment plant. Flows in excess of interceptor capacity are sent directly into a receiving stream.

Vietnamese "Design Standard TCVN 7957:2008" provides the following information on how to determine the interceptor pipe's capacity

(Design Standard 4.4.2)

$Q_n = Q_{kh} + n_0 \cdot Q'_{kh} + Q_m$

In which:

Q_n: Flow rate of interceptor

Q_{kh}: Average sewage flow into interceptor directly

n_0: Dilution coefficient

Q'_{kh}: Average sewage flow from overflow chamber

Q_m: Storm water flow into interceptor directly

(Design Standard 4.4.4)

n_0 = 1 to 3

Where:

1: for lower reaches of the sewer network i.e. near STP

3: foe upper reaches of the sewer network

All sewage and storm water is diverted into the interceptor at overflow chamber therefore; the formula of Design Standard 4.4.2 is rewritten as follows.

$Q_n = n_0 \cdot Q'_{kh}$

Interceptor sewers must be at least large enough to accommodate the peak dry weather flow which varies from 2.5 times of average flow in upstream sections to 1.44 in downstream sections where flows are higher. According to the above situation the minimum interception ratios proposed in the F/S report are as follows.

- Kc $\geqq$ 2 : n_0 = Kc
- Kc $<$ 2 : n_0 = 2

The Study Team has prepared a case study, presented in Appendix 4-A, to examine the impact of various interception ratios on the quantity of combined sewer overflows. It is estimated that 87.4% of the wet weather flow from the combined sewer area would overflow if the interception ratio was set to 3. An interception ratio of 1 would result in 95.8% overflow and the F/S proposed ratio of 2 provides 91.5% overflow. The analysis indicates that there is no significant difference in terms of quantity therefore the interception ratios proposed in F/S are deemed acceptable and used in this study.

- **Sewage Treatment Plant (STP)**

The STP is designed on the basis of daily maximum flow and sewage strength. The seasonal fluctuation in water consumption is negligible. The collection area is sufficiently large to attenuate diurnal flow variations therefore the a peaking factor of 1.15 times the daily average flow is selected for the treatment plant in accordance with Vietnamese “Design Standard TCVN 7957:2008”.

4.5.2 Sewage Strength

(1) Review of the Master Plan and the Feasibility Study

Sewage characteristics identified in the Master Plan and the F/S are based on Vietnamese standards and are shown in the Table 4.5.8.

Table 4.5.8 Design Sewage Characteristics in Master Plan and F/S

pH		: 6.5 - 7.5
BOD_5	(mg/l)	: 150 - 200
SS	(mg/l)	: 200 - 250
COD_{Cr}	(mg/l)	: 300 - 350
Total Coliform	(MPN/100ml)	: 10^6 - 10^7

Source: Master Plan and F/S Reports

The basic design of the treatment process in the F/S was based on the following values:

- BOD_5 : 200mg/l
- SS : 250mg/l

These values are validated by the calculation of sewage strength based on typical per capita loadings.

(2) Examples of Per Capita Pollution Load in Other Countries

Unit pollution load per capita in other countries/cities and Viet Nam are compared in Table 4.5.9. Per capita loading depends to a great extent on water supply conditions and life style.

Table 4.5.9 Examples of Per Capita Pollution Load

(unit: g/capita/day)

Country	Area/ Period	BOD	SS	T-N	T-P
Japan	1970	36	41	7	1.1
	2000	58	45	11	1.3
Indonesia	Jakarta	28	-	-	-
Thailand	Chaopia	53	25	-	-
	Puket	42	-	-	-
Viet Nam	Hanoi	40	-	-	-
	Ho Chi Minh	55	55	-	-

Source: ・The Guideline for Comprehensive Basin-wide Planning of Sewerage Systems, Japan Sewage Works Association 2000
・The Guideline for Establishment of the Master Plan in Developing Countries, Japan Sewage Works Association 1997

Assuming that future conditions in Bien Hoa City might be similar to those in Japan in 1970 the following sewage characteristics are calculated:

BOD_5	: 36 g/capita/day / 171 l/capita/day × 1,000	= 211 mg/l
SS	: 41g/capita/day / 171 l/capita/day × 1,000	= 240 mg/l
T-N	: 7g/capita/day / 171 l/capita/day × 1,000	= 41 mg/l
T-P	: 1.1g/capita/day / 171 l/capita/day × 1,000	= 6.4 mg/l

Note) unit sewage flow (2030), including infiltration

= (165 l/capita/day × 80% × 100%) × 1.3

= 171 l/capita/day

(3) Design Domestic Sewage Quality

The study team has adopted the following concentrations for the design of the treatment plant.

BOD_5: 200 mg/l **SS : 250 mg/l**	Based on M/P and F/S
T-N : 41 mg/l **T-P : 6.4 mg/l**	Based on typical sewage characteristics in Japan 1970.

4.5.3 Sewage Treatment Process

(1) Design Considerations for Sewage Treatment Plant (STP)

Three factors must be considered when designing the treatment plant:

- Effluent quality

- Capacity
- Buffer zone

1) Effluent Quality

Required effluent quality is identified in the Environmental Impact Assessment (EIA) report of the project on sewerage and sewage treatment for Bien Hoa City in Phase I approved at October 2008. Effluent must meet discharge limits specified in the National technical regulation on domestic wastewater (QCVN 14-2008/BTNMT). The regulations are indicated in Table 4.5.10.

Table 4.5.10 National Technical Regulation on Domestic Wastewater

No.	Item	Unit	A	B
1.	pH		5 – 9	5 – 9
2.	BOD_5 (20 ^oC)	mg/l	30	50
3.	Total suspended solids (TSS)	mg/l	50	100
4.	Total dissolved solids (TS)	mg/l	500	1,000
5.	Sulfide (H_2S)	mg/l	1	4
6.	Ammonia nitrogen (NH_4^+-N)	mg/l	5	10
7.	Nitrate nitrogen (NO_3^--N)	mg/l	30	50
8.	Mineral oil, vegetable oil	mg/l	10	20
9.	Total surface-active substances	mg/l	5	10
10.	Phosphate phosphorus (PO_4^{3-}-P)	mg/l	6	10
11.	Total coliforms	MPN/100ml	3,000	5,000

Note: A: apply for discharge into the resource which is used to Water treatment plant
B: apply for discharge into the resource which isn't used to Water treatment plant
Source: EIA Report, QCVN 14-2008/BTNMT

Effluent from the STP will be discharged at upstream of the Water Supply intake for Ho Chi Minh City therefore the effluent quality must as a minimum meet the requirements for category “A”.

According to Vietnamese Standard TCVN 7222:2002, the STP should remove more than 85% of the BOD and SS. The standard also provides guidance for selecting the appropriate level of treatment to achieve desired effluent quality (Table 4.5.11). Based on the standard a secondary treatment process is required. The 30 mg/l limit for TSS in TCVN 7222:2002 is more stringent than the discharge limit identified in the EIA and is therefore adopted for project design.

Table 4.5.11 Quality of the Typical Parameter in the Treated Domestic Sewage

Parameter	Preliminarily treated sewage – Level 1	Treated sewage – Level 2	Treated sewage – Level3
(1)	(2)	(3)	(4)
pH	6 to 9	6 to 9	6 to 9
BOD (mg/l)	100 to 200	10 to 30	5 to below 10
Total SS (mg/l)	100 to 150	10 to 30	5 to below 10
Total N (mg/l)	20 to 40	15 to 30	3 to 5
Total phosphor (mg/l)	7 to 15	5 to 12	1 to 2
Note: Quality level of the Treated Sewage- Level 3 in the column 4 is the result of advance, complex treatment process. Encourage investment and apply this technology.			

Source: TCVN 7222:2002

2) STP Capacity

The design flow for STP2 is shown in Table 4.5.12.

Table 4.5.12 Design Sewage Flow of STP2

Design Sewage Flow	Unit	2020 (Entire Service Area)	2020 (Priority Area)	Design Capacity of STP2*
Daily Average Flow	m^3/day	81,400	31,500	42,000
Design (Wet Weather) Flow	m^3/day	91,500	41,500	52,000
Peak (Hourly Maximum) Flow**	m^3/day	128,100	56,200	72,800

* Peak flow of design capacity is decided by rate of flow for entire service area. Daily average flow of design capacity is calculated by the desigen flow (52,000m^3/day) without rainwater.

** Calculation sheets are shown in Appendix 5-B.

The design capacity is decided by following reasons.

The proposed treatment plant will have an ultimate design capacity of 52,000 m^3/day as identified in the Master Plan and approved EIA. According to the Master Plan excess flows would be pumped to STP3 however it might be possible to treat some of the excess flow at STP2 by modifying or expanding the process.

The flow regime at STP2 and the quality of sewage will be influenced by wet weather inflow from the combined sewer area. According to TCVN 7957:2008, intercepted wet weather flows should not by-pass treatment. Wet weather flows can be processed through secondary biological treatment if the volume is not more than 10 - 20% of the dry weather flow. In this study the amount of storm water intercepted in 2020 (Priority Area) would be about 32%, but in 2030 (Entire Service Area) the amount would be about 12%. Therefore it is assumed that all wet weather flow will pass through the secondary process. This concept has been applied at Binh Hung STP in Ho Chi Minh City which also has a combined sewer system.

TCVN 7957:2008 specifies that the peaking factor coefficient applied to the daily average flow should be between 1.15 and 1.30. As discussed in Section 4.5.1 the Study Team has selected a peaking factor of 1.15. Since the design wet weather flow to STP2 includes 12% of rain water, the fluctuation in the daily average flow during wet weather is 1.29 (1.15×1.12). This is almost equal to the maximum peaking coefficient (1.30) in TCVN 7957:2008.

Therefore, the hydraulic capacity of the STP2 is determined on the basis of wet weather flow and a peaking factor of 1.15.

3) Buffer Zone

The size of the buffer zone around the STP is determined by QCVN-07:2010/BXD. The regulations are shown in Table 4.5.13.

Table 4.5.13 National Technical Regulation on Domestic Wastewater

No.	Items	Buffer zone (m) base on capacity (×1000m³/day)			
		< 0.2	0.2 － 5	5 － 50	>50
1.	Pumping Station	15	20	25	30
2.	Sewage treatment plant				
a.	Physical treatment (combine with Sludge drying bed)	100	200	300	400
b.	Biological treatment (combine with Sludge drying bed)	100	150	300	400
c.	Biological treatment without Sludge drying bed (combine with Sludge drying equipment, Sludge treated equipment)	10	15	30	40
d.	Underground sewage filter yard	100	150	300	500
e.	Sewage farming	50	200	400	1,000
f.	Biological pond	50	200		
g.	Sewage Oxidation channel	50	150		

Source: QCVN-07:2010/BXD

The capacity of STP2 is 52,000 m^3/day, the treatment process does not have a sludge drying bed therefore the required buffer zone is 40m.

(2) Sewage Treatment Process for STP

The selection of a an appropriate sewage treatment process is discussed taking the following factors into account;

- Required removal efficiency
- Footprint of the facilities compared to the area available
- Ease of operation and maintenance
- Construction cost
- Operation and Maintenance cost

The selection of a sewage treatment process is carried out in two stages. In the first stage, appropriate processes are screened using a qualitative evaluation of removal efficiency, space requirements and ease of O&M. In the second stage, processes selected in the first stage are evaluated quantitatively by comparing the construction, operation and maintenance costs.

1) Qualitative Evaluation of Sewage Treatment Process

a) Treatment Methods

Treatment methods in use and identified in planning studies in Viet Nam are identified in Table 4.5.14.

Table 4.5.14 Existing and Planned STP in Viet Nam

No.	STP Name	Location	Treatment Methods	Capacity (m^3/day)	Donor	Conditions
1	Truc Bach STP	Hanoi	Anaerobic-anoxic-oxic Activated Sludge	3,000 m^3/day	JBIC	Operation
2	Kim Lien STP	Hanoi	Anaerobic-anoxic-oxic Activated Sludge	3,700 m^3/day	JBIC	Operation
3	Van Tri STP	Hanoi	Conventional Activated Sludge	50,000 m^3/day	GOV	Operation
4	Ha Long STP	Ha Long City	Sequencing Batch Reactor	3,500 m^3/day	WB	Operation
5	Hoa Lac Hi-Tech Industrial Zone STP	Ha Tay province	Conventional Activated Sludge	6,500 m^3/day	GOV	Finished Construction
6	Vinh Yen Town STP	Vinh Phuc Province	Conventional Activated Sludge	5,000 m^3/day	JBIC	Construction Tender
7	Lien Chieu STP	Da Nang City	Conventional Activated Sludge	62,900 m^3/day	METI (Japan)	Before detailed design
8	Binh Hung STP	Ho Chi Minh City	Conventional Activated Sludge	141,000 m^3/day	JBIC	Operation
9	Thu Dau Mot STP	Binh Duong Province	Sequencing Batch Reactor	17,650 m^3/day	JBIC	Under Construction
10	Bay Mau STP	Hanoi	Conventional Activated Sludge	13,300 m^3/day	JBIC	Under Construction
11	Vinh Niem STP	Hai Phong Province	Conventional Activated Sludge	36,000 m^3/day	JBIC	Under Construction
12	North Thang Long STP	Hanoi	Conventional Activated Sludge	42,000 m^3/day	JBIC	Operation
13	Thuy An STP	Hue City	Conventional Activated Sludge	20,000 m^3/day	JBIC	Before detailed design

In other tropical countries, the upflow anaerobic sludge blanket (UASB) process is often used because it requires less energy and has a smaller footprint. However, UASB effluent has BOD5 above the normally acceptable limit of 50 mg/l and is anoxic. UASB is usually combined with a trickling filter or polishing pond to achieve good quality effluent.

The following 5 types of treatment processes are evaluated by the Study Team:

- Aerated Lagoon
- Oxidation Ditch
- Conventional Activated Sludge
- Sequencing Batch Reactor
- UASB +trickling filter

b) Required Removal Efficiency

The required removal efficiency is calculated based on the designed influent quality and the required effluent quality. The required removal efficiency is presented in Table 4.5.15.

Table 4.5.15 Calculation of Required Removal Efficiency

	Influent Quality	Including recycle flow	Design Influent Quality	Effluent Standard*2	Required Removal Efficiency
BOD	200 mg/l	255 mg/l	260 mg/l	30 mg/l	88.5%
SS	250 mg/l	312 mg/l	320 mg/l	30 mg/l	90.6%
T-N*1	41 mg/l	52 mg/l	60 mg/l	30 mg/l	50.0%
T-P	6.4 mg/l	7.5 mg/l	9 mg/l	6 mg/l	33.3%

*1: T-N of Effluent Standard means nitrate-nitrogen (NO_3^--N).

*2: Source: QCVN14-2008 / BTNMT and TCVN7222:2002

The discharge limit for ammonia nitrogen (NH_4^+-N) is determined by QCVN14-2008 / BTNMT. Ammonia nitrogen must be reduced to less than 5mg/l by nitrification, denitrification, and assimilation.

c) Required Facilities and Site Area

The site for the STP2 has already been selected and expropriation of households has been approved. The total area available is 93,400 m^2. A 40 m buffer zone is required when the biological treatment without sludge drying bed is selected as treatment process. Therefore, the area available for the STP is 50,400m^2 (280m×180m).

d) Qualitative Analysis

The five treatment methods are evaluated qualitatively using a design flow of 52,000m^3/day. The results are summarized in Table 4.5.16.

Based on the evaluation, three treatment methods are rejected for the following reasons.

- Aerated Lagoon: The required removal efficiency for BOD^5, SS and T-P is not satisfied and the site is too small.
- Oxidation Ditch: The site is too small.
- UASB + Trickling filter: The required removal efficiency for ammonia nitrogen is not satisfied because this method cannot nitrify (Oxidization of ammonia by aeration).

Table 4.5.16 Comparison of Five Treatment Methods by the Qualitative Evaluation

Treatment Method	1. Aerated Lagoon (Facultative)	2. Oxidation Ditch	3. Conventional Activated Sludge (CAS)	4. Sequencing Batch Reactor	5. UASB + Trickling Filter (T.F.)
Composition of Sewaget treatmet Process	→ R.T.(1) → R.T.(2) →	→ R.T. → S.S.T. → Sludge Treatment Facility	→ P.S.T. → R.T. → S.S.T. → Sludge Treatment Facility	→ F.E.T. → R.T. → Sludge Treatment Facility	→ UASB → T.F. → S.S.T → Sludge Treatment Facility
Theory of Reaction in Reactor Tank	Sewage is purified by oxidation of aerobic bacteria activated by oxygen supply through algae or anaerobic bacteria.	Sewage is circulated together with activated sludge and contained organic substance is absorbed and assimilated by activated sludge.	Sewage flows down together with activated sludge and contained organic substance is absorbed and assimilated by activated sludge.	The four processes of (1) Inflow, (2) Aeration, (3) Sedimentation, (4) Effluent and sludge draining are occurred in the one tank.	Solids of sewage settles and it is anaerobic digested in UASB (Upflow Anaerobic Sludge Blanket) tank, and nitrificated and purified in Trickling Filter.
Water Quality (removal effency)	BOD : 70%	BOD : 90-95%	BOD : 90-95%	BOD : 90-95%	BOD : 85-95%
	SS : 70%	SS : 90-95%	SS : 90-95%	SS : 90-95%	SS : 70-90%
	T-N : 40-50%	T-N : 70% over	T-N : 60%*	T-N : 70% over	T-N : 30-40%
	T-P : 20-30%	T-P : 30%	T-P : 30-40%	T-P : 30-40%	T-P : 30%
	It is unsatisfactory about BOD, SS and T-P.	It is satisfactory about all items.	It is satisfactory about all items.	It is satisfactory about all items.	It is unsatisfactory about SS and T-N.
	Not satisfied	Satisfied	Satisfied	Satisfied	Not satisfied
Required Site Area (without buffer zone)	21.6 ha	7.1 ha	3.6 ha	5.2 ha	5.4 ha
	Necessary for bigger space	Necessary for bigger space	Enough space	Possible to arrage facilites	Possible to arrage facilites
Stability of Flow Fluctuation (rain)	Very Stable	Very Stable	Stable	Not Stable	Not Stable
Operation and maintenance (O&M)	O&M is easy since there is simple euipment. Sludge treatment facility in not needed.	Operationl technique is easier than that of CAS method. Ganerated sludge volume is small.	Relatively high O&M technique is required because large blowers are installed. The system has an relatively stableoperation when rain go into STP because primary sedimentation tank works as a buffer tank for fluctuation of flow.	High O&M technique is required because large blowers, many monitoring devices and automatic valves are installed. The system without large equalization tanks has very unstable when rain go into STP.	Relatively high O&M technique is required because anaerobic process. Ganerated sludge volume is small. The system without large equalization tanks has very unstable when flow is changed.
	Very Simple	Simple	Not simple	Not simple	Not Simple
Evaluation	×	×	◎	○	×

Legend : P.S.T. : Primary Sedimentation Tank R.T. : Reactor Tank S.S.T : Secondary Sedimentation Tank F.E.T : Flow Equalization Tank
* : Operating of nitrification and denitrification

2) Quantitative Evaluation of Sewage Treatment Process

Qualitative evaluation indicates that only the Conventional Activated Sludge (CAS) and the Sequencing Batch Reactor (SBR) processes can meet site constraints and required effluent quality.

These two alternatives are compared using a quantitative evaluation.

a) Capacity Calculation and Structural Outline Drawing

The capacity calculation for each treatment process is shown at Appendix 4-B. The structural outline drawing based on capacity calculation is shown at Figure 4.5.1 and Figure 4.5.2.

b) Approximate Cost

The approximate construction and operating costs for each treatment process are estimated on the basis of concrete volume, weight of structures and main mechanical equipment list.

c) Odor Control Requirements

Since the STP is located in an urban residential area, minimizing the source of odors is important.. Process areas that need odor control are calculated for each treatment method.

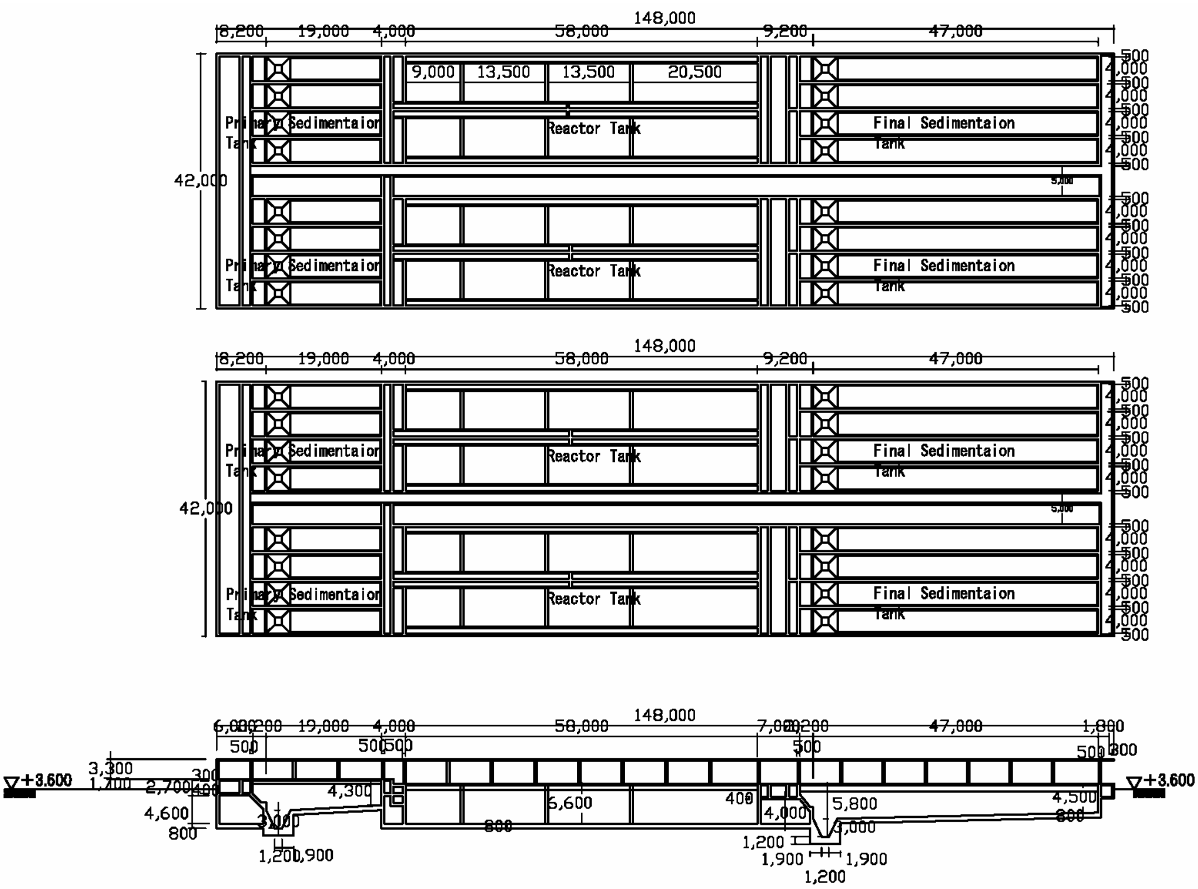


Figure 4.5.1 Structural Outline Drawing for CAS Process

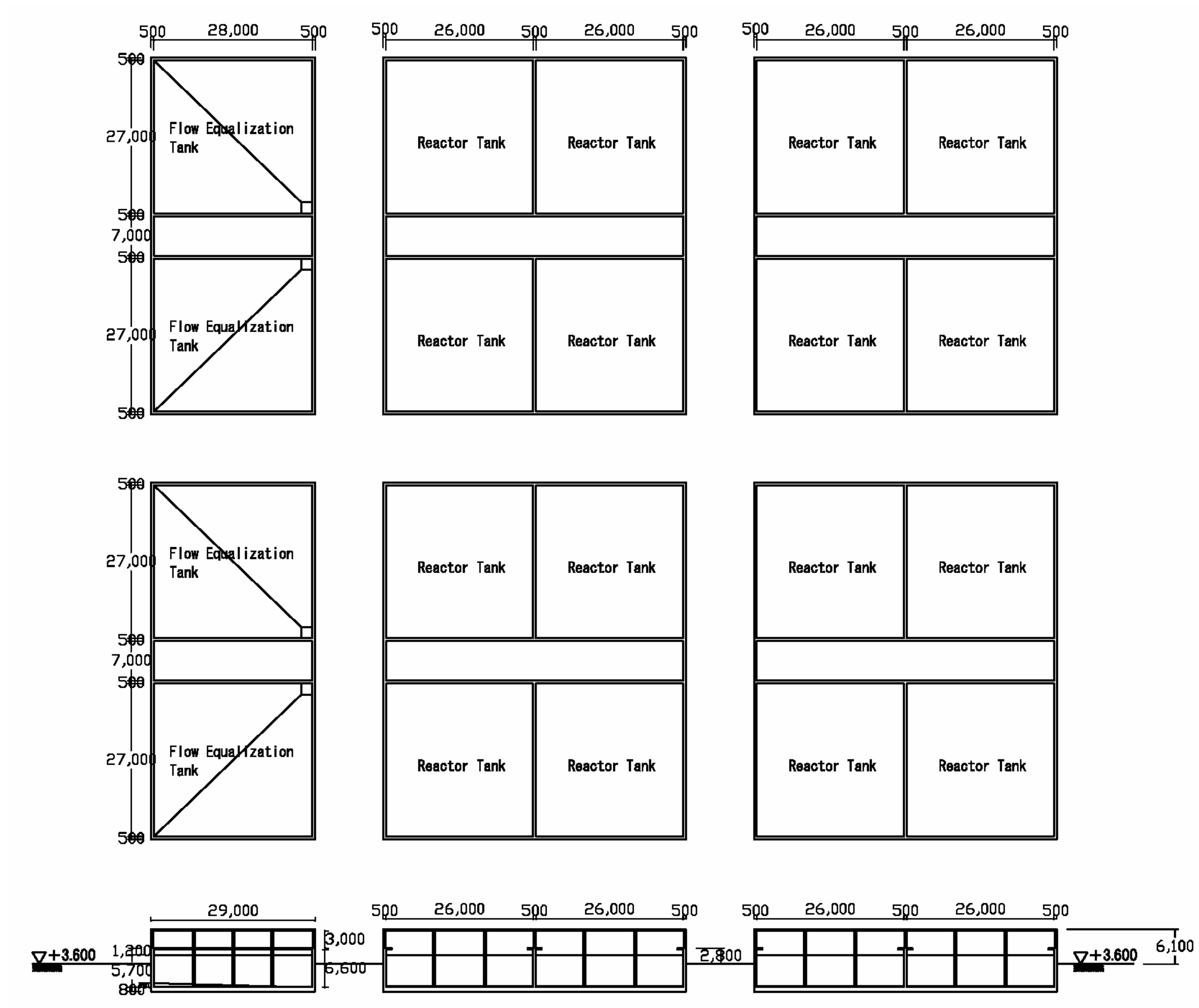


Figure 4.5.2 Structural Outline Drawing for SBR Process

d) Adequacy for Combined Sewerage

Almost 30 % of the area in the priority project I is served by a combined sewer system. The large volume of wet weather influent which is almost two times the average dry weather flow will be treated through the secondary biological process. Therefore, the ability of the treatment method to deal with a large increase of dilute sewage is considered when evaluating the treatment method.

e) Nitrogen Removal

Nitrogen removal occurs in two ways. One way is that nitrogen is accumulated in microorganisms. Then, nitrogen is removed from sewage. The other way is through the process of nitrification-denitrification which occurs in two stages. In the first stage ammonia nitrogen is converted to nitrate and nitrite by aerobic process. This stage is called nitrification. At the second stage nitrate and nitrite is converted to nitrogen gas under anoxic conditions by microorganisms that use nitrogen. This stage is called as denitrification. The denitrification process releases nitrogen gas from the process stream.

Biological nitrification-denitrification is possible with both CAS and SBR processes which can remove more than 50% of the total nitrogen to meet required effluent quality.

- CAS process: denitrification occurs by setting up an anoxic zone in a part of the reactor
- SBR process: denitrification is achieved by cycling the aeration blowers off for a period of time to create anoxic conditions.

For SBR with continuous flow, nitrification of ammonia is not completely achieved because the aeration time for nitrification is too short. Therefore continuous flow SBR cannot satisfy the discharge limit for ammoniac nitrogen specified in QCVN 14-2008/BTNMT.

f) Quantitative Analysis

The results of the quantitative evaluation are summarized in Table 4.5.17. (Refer to Appendix 4-C)

The results of cost comparisons are as follows.

- The equipment and electric facility costs for SBR is less than CAS but the civil structural costs for SBR are higher. Therefore the total construction cost for CAS is less than SBR.
- The operating costs for SBR are higher than CAS mixing tank for denitrification is required.
- The total construction and operating costs for CAS is less than SBR, but the life-cycle cost including equipment replacement is approximately same for both processes. The reason is that the equipment for CAS has higher equipment replacement cost

Based on the evaluation, the CAS process is selected as the preferred alternative for the following reasons.

- Area requiring odor control is smaller than that of SBR.
- Annual cost is approximately same as SBR cost.
- Construction cost and electric power cost are less than SBR cost.

Although the Study Team recommends the CAS process, the PMU has indicated that it would also like to consider the SBR system because the equivalent life-cycle cost for both processes is the same. The sewage treatment method is finally decided by Vietnamese side in later stages.

Table 4.5.17 (1) Comparison of CAS and SBR by the Quantitative Evaluation

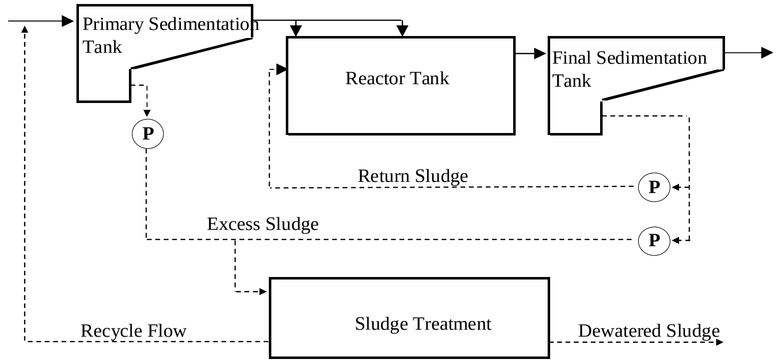
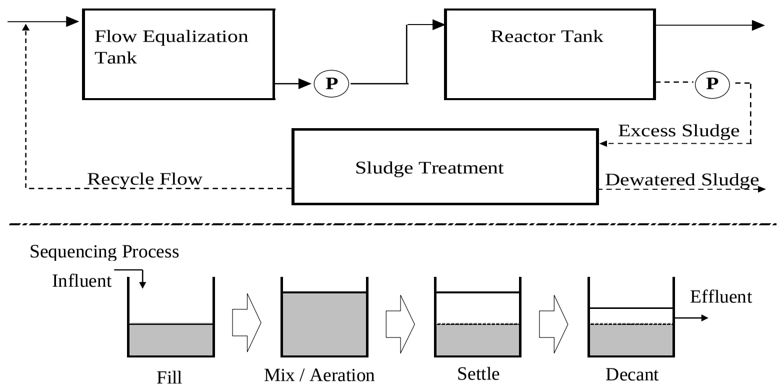
Items	Conventional Activated Sludge Method (CAS) with nitrogen removal		Sequencing batch reactor (SBR)	
Brief Summary of Treatment process	 *** This reactor can treat nitrogen by nitrification denitrification process.**			
	The CAS process has three tanks as primary sedimentation tank, reactor tank, final sedimentation tank. First sewage is treated at primary sedimentation tank to settle particles. After primary sedimentation treatment, wastewater is biologically treated. BOD and TN is removed by aeration and nitrification/denitrification. Finally microorganisms in wastewater is separated at final sedimentation tank. Treated wastewater goes to disinfection facility.		The SBR is a fill and draw type of reactor system involving a single complete mix reactor in which all steps of the activated sludge process occur. In generally, at least two basins are used so that one basin is in the fill mode while the other goes through react, solids settling, and effluent withdrawal. All SBR systems have four steps in common, which are carried out in sequence as follows; (1) fill, (2) react (aeration and mix), (3)settle, (4) decant and idle. This process requires flow equalization tank due to stable treatment.	
Deodorizing Area (Capacity of daily average flow 52,000 m^3/day)	Primary Sedimentation Tank (strong odor)	1,700 m^2	Flow Equalization Tank (strong odor)	3,000 m^2
	Reactor Tank	4,400 m^2	Reactor Tank	11,200 m^2
	Total	6,100 m^2	Total	14,200 m^2
	Deodorizing area is less than SBR due to small surface area of reactor tank and no equalization tank for rain.		Deodorizing area is larger than CAS due to large surface area of reactor tank and equalization tank for rain.	
	○		△	
Adequacy for Combined Sewerage (In case rainwater inflow)	The CAS process which is a plug-flow process can treat all inflow by changing hydraulic retention time when inflow increases during rain. Since wastewater quality is diluted by rain, treated water quality is secured by short retention time.		The cycle time of SBR process become short in time with increase pump discharge of equalization tank. Since wastewater quality is diluted by rain, treated water quality is secured by short retention time.	
	○		○	

Table 4.5.17 (2) Comparison of CAS and SBR by the Quantitative Evaluation

Items	Conventional Activated Sludge Method (CAS)			Sequencing batch reactor (SBR)		
Denitrification Method	Denitrification efficency increases due to anaerobic tank is put on the front of reactor.			Denitrification efficency increases due to cycle through anaerobic and aerobic conditions in the reactor.		
	○			○		
Maximum Capacity at the STP2 Site (Available Area about 5.04 ha)	Daily Average Flow	91,500	m^3/day	Daily Average Flow	70,000	m^3/day
	Daily Maximum Flow	105,300	m^3/day	Daily Maximum Flow	80,500	m^3/day
	○			△		
Construction Cost (Capacity of daily average flow 52,000 m^3/day)	Civil structures	582,000,000,000	VND	Civil structures	662,000,000,000	VND
	Machine and Electric facilities	632,000,000,000	VND	Machine and Electric facilities	554,000,000,000	VND
	Total	1,122,000,000,000	VND	Total	1,216,000,000,000	VND
	○			△		
Operation Cost (Capacity of daily average flow 52,000 m^3/day)	Consumed power	14,584	kWh/day	Consumed power	18,161	kWh/day
	Electric power cost	25,640,000	VND/day	Electric power cost	31,930,000	VND/day
	○			△		
Equivalent Annual Cost (i = 0.07)	Operation Cost	10,000,000,000	VND/year	Operation Cost	12,000,000,000	VND/year
	Civil structures cost (50years)	42,000,000,000	VND/year	Civil structures cost (50years)	48,000,000,000	VND/year
	Machine and Electric facilities (15years)	69,000,000,000	VND/year	Machine and Electric facilities (15years)	61,000,000,000	VND/year
	Total	121,000,000,000	VND/year	Total	121,000,000,000	VND/year
	○			○		
Comprehensive Evaluation	Although total cost including construction cost and O&M cost of CAS and SBR is the same, but the O&M cost of CAS process is less than SBR. The CAS process is a suitable process on the environmental aspects because deodorizing area is less than that of SBR. In general recommended of capacity of SBR in terms of O&M is less than 20,000m^3/d. Moreover, CAS process can reduce the land acquisition for No3 site because the CAS process at No2 Site treats much more wastewater than SBR.					
	○					

Note: Equivalent Annual Cost = Construction Cost × I (Coefficient)

$I = i \times (i+1)^n / ((i+1)^n - 1)$, i = annual interest, n = depreciation period

(3) Sludge Treatment Process

The disposal of sludge causes handling problems that must be tackled hygienically and economically. The handling of liquid sludge is difficult and costly, therefore sludge thickening and dewatering processes are provided at the STP in order to reduce the volume and weight of sludge that must be processed and transported to disposal sites. Sludge processing consists of: sludge thickening (primary and secondary sludge are combined), sludge conditioning by polymer addition, mechanical sludge de-watering, and ultimately disposal to landfill.

Thickening increases the solid content of sludge by removing a portion of the liquid prior to dewatering. Gravity thickening has been selected because it is easily operated, cost less and is the most energy efficient option

Dewatering methods commonly used are as follows:

- Natural dewatering methods such as sludge drying bed
- Mechanical dewatering methods such as belt filter press, centrifuge, screw press

Sludge drying beds cannot be constructed at this STP because a 400m buffer zone would be required and there is not enough space. The each mechanical dewatering method is described as follows.

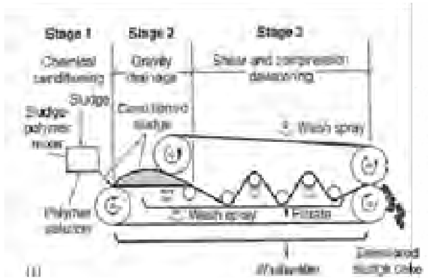
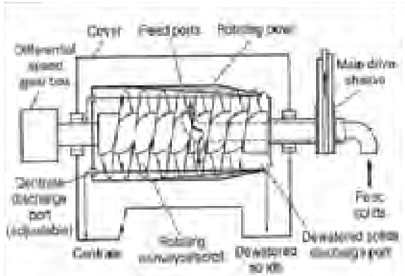
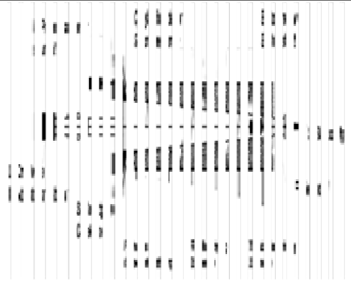
- Belt filter press: The sludge to be treated is fed into the gravitational dewatering zone, wedge zone, then into compression dewatering zone with rolls equipped at the upper and lower side of the frame in which the solid content of the sludge is gradually increased by sharing force and roll pressure. Finally, the sludge is dewatered to the highest possible cake solids in the press zone then discharged.

- Centrifuge: The sludge to be treated is fed into the bowl through the feed pipe and separated by centrifugal force into dewatering cake and filtrate. The cake is discharged by the screw which rotates at a speed that is slightly different from that of the bowl. At the opposite end, the filtrate is discharged as it overflows the weir.

- Screw press: The sludge to be treated is fed into the filter chamber in a continuous rotated screw and the pore water in flocks is filtered by the outer cylinder screen. In addition, the sludge is moved by the rotation of the screw, it is compressed by the screw and the presser unit. The sludge cake is discharged from the slit between the outer cylinder screen and the presser unit.

Three mechanical dewatering methods (belt filter press, centrifuge, screw press) are compared in Table 4.5.18. The screw press is recommended because it is easy to operate and maintain, minimizes odors and costs less to operate.

Table 4.5.18 Comparison of Sludge Dewatering Method

Dewatering Method	Belt Filter Press	Centrifuge	Screw Press
Flow Sheet			
Required Machine Capacity & Number	3m × 10machines (standby 2 machine)	20m3/hour ×8machines (standby 2 machine)	ϕ 1000mm × 6machines (standby 2 machine)
	△	○	◎
Solid Concentration	Fair (about 20% over)	Fair (20% over)	Good (22% over)
	○	○	◎
Noise & Vibration	Less	Loud	Less
	○	△	○
Odor control	Odor release easily and it require using water for cleaning.	Odor release is less and also water requirement for cleaning is less.	Odor release is less and also water requirement for cleaning is less.
	△	○	○
Sludge Condition & Fluctuation	Good	Good	Fair
	◎	◎	○
Operation	Many Inspected items	Less Inspected items	Easier than others
	△	○	◎
Maintenance	Easier than others	Skilled maintenance personal required. Need a periodical annual inspection. Spare parts are expensive.	Skilled maintenance personal required. Spare parts are expensive.
	◎	△	○
Construction cost (VND)	378,000,000,000	414,600,000,000	376,700,000,000
	100%	110%	100%
	○	△	○
O & M cost (VND/year)	588,500,000	2,216,800,000	371,700,000
	100%	377%	63%
	○	△	◎
Equivalent Annual cost (VND/year)	27,048,500,000	31,238,800,000	26,740,700,000
	100%	115%	99%
	○	△	○
Evaluation			○

Note: Equivalent Annual cost = Construction Cost × I (Coefficient) + O&M cost $I = i \times (i+1)^n / ((i+1)^n - 1)$, i = annual interest (0.07), n = depreciation period (15)

(4) Odor Control Method

In sewerage treatment facilities there are two major sources of odor. They are; a) preliminary treatment facilities and b) sludge treatment facilities. Therefore, in sewage treatment facilities, odor control measures are provided primarily for these two facilities only. Following these practices, it is proposed that all preliminary treatment facilities and sludge treatment facilities be located in a single specially ventilated building with odor control facilities. Therefore the layout of the unit processes should put all preliminary and sludge treatment facilities in close proximity to each other.

Table 4.5.19 shows the odor intensity ranking based on Japanese experiences. Ranking represents the relationship between odor intensity and perceived smell level. In Japan, the odor intensity of 3 i.e. “perceive smell clearly” is considered as the threshold limit for bad odor.

Table 4.5.19 Japanese Regulations Regarding Odor Intensities

Main offensive odour material	Odour Intensity							Character
			Standard Extent					
	1	2	2.5	3	3.5	4	5	
H_2S	0.0005	0.006	0.02	0.06	0.2	0.7	8	Addled egg smell
NH_3	0.1	0.6	1	2	5	10	40	Irritated smell
CH_3SH	0.0001	0.0007	0.002	0.004	0.01	0.03	0.2	Addled onion smell

*) Odor Intensity 0: Non smell, 1: Perceive smell barely, 2: Perceive smell, but very weak, 3: Perceive smell clearly, 4: Strong odor, 5: Very strong odor

Source: Guideline & Explanation of Sewerage Facility Plan & Design (Japan Sewerage Works Association)

Table 4.5.20 shows the example of actual measurements in Japanese STPs for various indicative hydrogen sulphide concentrations. The facilities with an maximum hydrogen sulphide concentration of more than 0.06 ppm are generally covered and provided with odor control equipment. The final sedimentation tank does not need odor control because the average and maximum hydrogen sulphide concentration is lower than 0.06 ppm.

Table 4.5.20 Indicative Hydrogen Sulphide Concentration in Japan

Facility	Average	Maximum
Preliminary treatment facilities	0.083 ppm	22 ppm
Prelimary sedimentation tank	0.107 ppm	44 ppm
Reactor tank	0.004 ppm	3.5 ppm
Final sedimentation tank	0.003 ppm	0.058 ppm
Sludge Gravity Thickener	1.260 ppm	77 ppm
Sludge Storage Tank	9.990 ppm	740 ppm

Source: Guideline & Explanation of Sewerage Facility Plan & Design (Japan Sewerage Works Association)

1) Odor Control Method

For controlling odor at the proposed treatment facility, three different odor control options are considered here. Brief descriptions for each of these three options are as follows;

a) Option 1; Activated Carbon Adsorption

The odorous gases are allowed to pass through a three-stage activated carbon filter. Adsorption into activated carbon removes the bad odor.

b) Option 2; Chemical Scrubber

In this option the odorous gases are allowed to pass through a specially designed scrubbing tower. Odor will be removed by chemicals in the scrubbing tower.

c) Option 3; Bio-filter

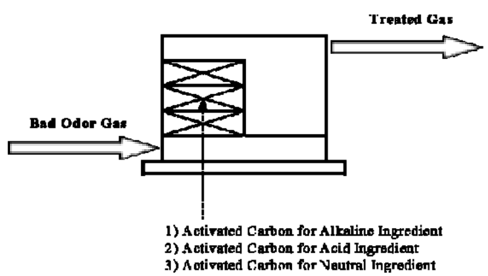
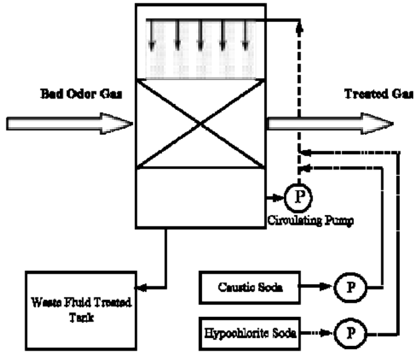
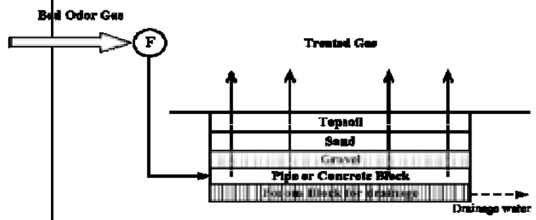
The odorous gases are allowed to pass through an earth filter. Odor is expected to be removed by the biological activity in the earth filters.

2) Comparison of the Odor Control Options and Recommendations

A comparative study of the three odour control options is carried out using criteria such as the stability of treatment, ease of O&M and cost. A comparison of the options is presented in Table 4.5.21. According to the above comparison, the option of using activated carbon absorption is selected as the most appropriate odor control method for the proposed treatment facility. Main reasons for this selection are listed below.

- It is reliable and consistent.
- It is simple to operate & maintain.
- Associated other risk factors are least in this option.
- The cost is lower than the chemical scrubbing.
- The Bio-filters require spading of the field periodically; it is highly possible that holes may be created during this process allowing untreated odors to escape causing nuisance conditions.

Table 4.5.21 Comparative Study of Treatment Method for Odor Control

Method		Activated Carbon Absorption	Chemical Scrubber	Bio-filter
Description		Odorous gases passed through beds of activated carbon to remove odors	Odorous gas passed through specially designed scrubbing tower to remove odor using chemicals	Odorous gas is passed through an earth filter to remove odors using biological activity
Flow Sheet				
Treatment Effect	H_2S	○	○	○
	NH_3	○	○	○
	CH_3SH	○	○	×
	$(CH_3)_2S$	○	○	×
	CH_3SSCH_3	○	○	×
	$(CH_3)_3N$	○	○	○
Stability of Odor Fluctuation		Good	Good	Control limited
		◎	◎	△
Operation & Maintenance		Periodic replacement of activated carbon	Periodic supply of chemicals, and check to many machines	Need to water, weed and spade the field periodically
		◎	○	△
Other Regards		Moisture can reduce adsorption of odors. The annual requirment of exchange cartridges is increase by very strong odor.	Need protection for acid. The spent chemicals must be properly disposed.	Requires substantail space (about 700m2). Spading will craete holes through which untreated odor will escape.
		○	△	△
Construction Cost (VND)		14,872,000,000	21,875,000,000	16,943,000,000
		100%	150%	110%
		○	△	○
O & M Cost (VND/year)		382,600,000	696,000,000	184,700,000
		100%	182%	48%
		○	△	◎
Equivalent Annual Cost (VND/year)		1,423,600,000	2,227,000,000	1,370,700,000
		100%	156%	96%
		○	△	○
Evaluation		○		

Note: Equivalent Annual cost = Construction Cost × I (Coefficient) + O&M cost $I = i \times (i+1)^n / ((i+1)^n - 1)$, i = annual interest (0.07), n = depreciation period (15)

(5) Disinfection Method

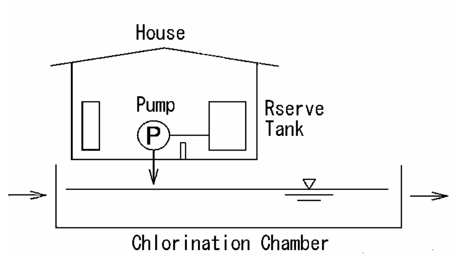
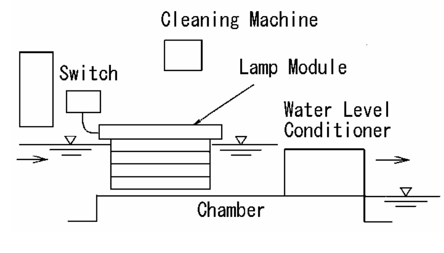
The most classical disinfection method is chlorine in many countries. In Viet Nam, the chlorine disinfection method is adopted at many STPs such as Binh Hung STP in Ho Chi Minh City. Chlorine disinfection also has some disadvantages. One disadvantage is that sodium hypochlorite is expensive because it is an import product. The other one is trihalomethanes (THMs). Chlorine reacts with organic materials to form trace amounts of chlorinated hydrocarbons called trihalomethanes (THMs). THMs are suspected as being carcinogens.

Many sewage treatment plants are shifting from chlorine-based disinfection to UV disinfection to eliminate the risk of storage and handling of toxic chemicals. Although UV disinfection is energy intensive, it adds no chemical residue to the effluent. This feature is particularly important when treated sewage is reused or discharged to sensitive aquatic environments.

The UV radiation disinfection method is adopted on a small scale in Thu Dau Mot STP of Binh Duong Province to disinfect process water used for gardening at STP.

A comparison of chlorination and UV disinfection methods is shown in Table 4.5.22.

Table 4.5.22 Comparison for Disinfection Methods

Disinfection Methods	Chlorination	UV Radiation
Figure		
Facility	Simple	Little Complex
	◎	○
Operation & Maintenance	Making chemical weekly.	Exchanging the lamp annual.
	○	○
Byproduct	THMs	No
	△	◎
Risk of impact for Human	Low danger (Leakage of chlorine gas)	Low danger (Expose the lamp directly)
	○	○
Construction Cost (VND)	45,887,000,000	116,744,000,000
	100%	254%
	◎	○
Operation & Maintenance Cost (VND/year)	4,838,000,000	1,268,000,000
	100%	26%
	○	◎
Equivalent Annual Cost (VND/year)	9,371,000,000	13,994,000,000
	100%	149%
	◎	○
Evaluation		○

Note: Equivalent Annual cost = Construction Cost × I (Coefficient) + O&M cost
I = i ×(i＋1)n / ((i＋1)n -1), i = annual interest (0.07), n = depreciation period (15 for equipment or 50 for civil structure)

UV Radiation is recommended in this study. The reasons for recommendation are indicated below.

1) It doesn't create toxic materials such as Trihalomethanes (THMs).
2) O&M cost is lower than that of chlorination although the construction cost is higher.

4.6 Facilities for the Reduction of Green House Gas Effect

Burning digester gas from anaerobic digestion to produce electricity can produce 20 – 30% of the plants energy needs. The feasibility of using anaerobic digestion is studied in this section.

4.6.1 Sludge Treatment Alternatives

The proposed sludge treatment process (Case1) is compared with anaerobic sludge digestion process (Case2) to compare potential GHG reduction impacts and economic benefits.

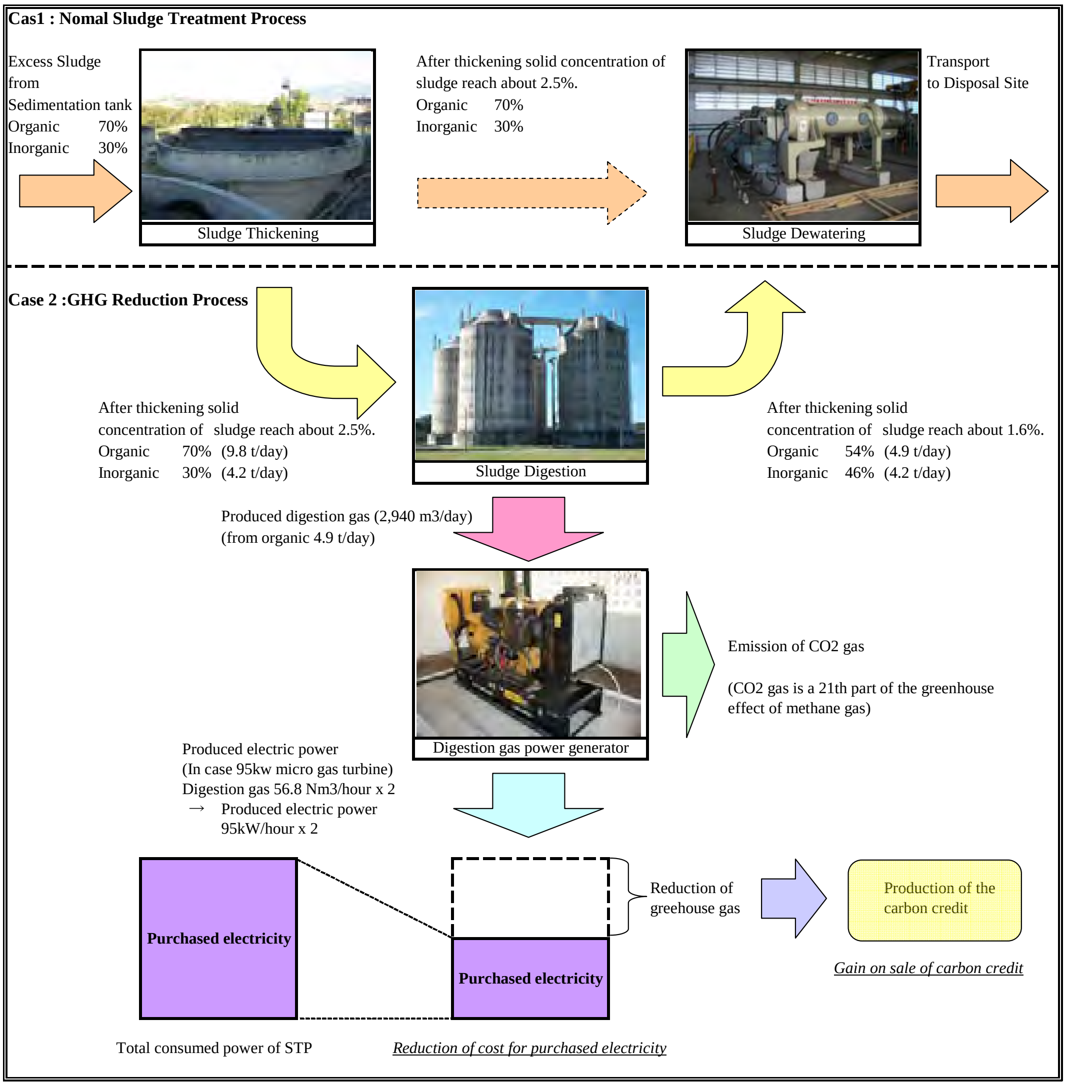


Figure 4.6.1 Summary of Each Sludge Treatment Process

The design conditions for each treatment process are summarized in Table 4.6.1.

Table 4.6.1 Condition of Each Treatment Process

		Case1 (Without digestion)	Case2 (With digestion)
Design average daily flow	m^3/day	52,000	52,000
Condensed sludge by thickener			
Sludge weight	t/day	15.56	15.56
Solid ratio	%	2.50	2.50
Sludge volume	m^3/day	622.40	662.40
Ratio of volatile solids	%	70.00	70.00
Volatile solids	t/day	10.89	10.89
Non-volatile solids	t/day	4.67	4.67
Digester			
Digestion coefficient	%		50
Digestion temperature	^{0}C		30
Detention time	Days		20
Digester volume	m^3		12,448
Gasification sludge	t/day		4.90
Unit gasification volume	m^3/t		600
Gas yield	Nm^3/hour		123
Gas retention time	Hour		12
Gas holder volume	m^3		1,470
Capacity of micro gas turbine	Nm^3/hour		56.8
Dewatering			
Solid collection rate	%	95	95
Input sludge weight	t/day	15.56	10.12
Output sludge weight	t/day	14.78	9.61
Output solid ratio	%	24	19
Output sludge volume	m^3/day	61.58	50.58
Operation days for a week	Days/week	6	6
Operation times for a day	hours/day	7.0	7.2
Dewatering Capacity	kg/h	2,593	1,640
Filtration rate	kg/h・φ100	4.4	2.6
Diameter of dewatering machine	Mm	1000	1000
Unit dewatering capacity	kg-ds/hour	697	412
Number of machines		4	4
Chemical injection ratio	%	1.0	1.4
Chemical injection weight	t/day	0.148	0.135

The amount of digester gas is calculated from the following formula.

V = 4.90 t/day (Gasification sludge) × 600 Nm^3/t (Unit gasification volume*)

= 2,940 Nm^3/day

*Unit gasification volume refer to Guideline & Explanation of Sewerage Facility Plan & Design (Japan Sewerage Works Association)

The sludge processing facilities for each option are shown in Table 4.6.2. The digestion process can reduce the amount of solids that have to be processed, but the disadvantage is that the sludge becomes more difficult to dewater. Therefore the number of dewatering machines for Case 1 and Case 2 is the same even though the input volume for Case 2 is smaller. Case 2 is more expensive to build because it requires additional structures and equipment such as digester tanks, micro gas turbine, gas holder, and desulphurization facilities.

Table 4.6.2 Facilities of Each Treatment Process

Process	Case1		Case2	
	Specifications	Numbers	Specifications	Numbers
Thickening	Thickener (Diameter 10m)	4	Thickener (Diameter 10m)	4
Digestion			Digester tank (Diameter 14m×Height13m)	6
			Micro gas turbine (95kW)	2
			Gas holder (800Nm^3)	2
			Desulphurization facilities (70Nm^3/hour)	2
			Excess gas burning equipment (130Nm^3/hour)	2
Dewatering	Screw press dewatering machine (Diameter 1,000mm)	6	Screw press dewatering machine (Diameter 1,000mm)	6

4.6.2 The GHG Reduction

Generally coal fired power plants emit CO_2. The electricity produced by anaerobic digestion (Case2) has the potential to reduce CO_2 emissions by generating electricity from methane to satisfy part of the energy demand at the plant.

The amount of power generated by digestion is calculated as follows.

The number of gas turbine is 2 based on the amount of gas produced and the capacity of micro turbine.

N = 2,940 Nm^3/day / 24 hours / 56.8 Nm^3/hour (Capacity of micro gas turbine)

= 2.16 → 2 machines

The generated power is 1,331,520 kWh/year based on the number and the output power of micro gas turbine.

Q = 95kWh (Output power from micro turbine) × 2 machines × 0.8 (Availability factor)

× 24hours × 365days

= 1,331,520 kWh/year

The CO_2 emissions per kWh from power generation in Viet Nam is shown in Table 4.6.3.

Table 4.6.3 CO_2 Emissions per kWh from Power Generation (kg-CO_2/kWh)

	2006	2007	2008	Average
Viet Nam	0.448	0.430	0.413	0.430
Japan	0.418	0.452	0.436	0.436

Source: CO_2 emissions from fuel combustion (2010 edition, International Energy Agency)

The GHG reduction is calculated as follows:

GHG Reduction Weight = 1,331,520 kWh/year × 0.430 kg-CO_2/kWh
= 572,553 kg-CO_2/year
= 572 ton-CO_2/year

4.6.3 Economic Evaluation of the Anaerobic Digestion Process

The expected trading price of CO_2 emissions is obtained from the Nikkei-JBIC Carbon Quotation Index (N-C Carbon) issued by Environment Finance Engineering Department in JFC (Japan Finance Corporation) and JBIC (Japan Bank for International Cooperation). The expected trading price of CO_2 emissions is shown in Table 4.6.4.

Table 4.6.4 Expected Price of CO_2 Emission Trading Price (Yen/CO_2-t)

	End of Dec 2010	End of Jun 2011	End of Dec 2011
Average	1,470	1,589	1,731
	(368,970 VND/t)	(398,839 VND/t)	(434,481 VND/t)
Maximum	1,800	1,920	2,500
	(451,800 VND/t)	(481,920 VND/t)	(627,500 VND/t)
Minimum	1,200	1,300	1,300
	(301,200 VND/t)	(326,300 VND/t)	(326,300 VND/t)

Source: The Questionnaire for vision of CO_2 emission trading price on Environment Finance Engineering Department in JFC and JBIC

The potential income from selling CO_2 credits is as follows.

Income (Maximum) = 627,500 VND/t × 572 t/year = 358,930,000 VND/year
(Minimum) = 326,300 VND/t × 572 t/year = 186,643,600 VND/year

As shown in Table 4.6.5 the anaerobic digestion process is not economically justified.

Table 4.6.5 Economical Evaluation for Digestion Process

	Unit	Case 1 (Without Digestion)	Case 2 (With Digestion)
Sludge Treatment Facilities Construction Cost			
Civil Structure	VND	111,922,900,000	225,598,900,000
Mechanical and Electric Equipment	VND	472,072,200,000	659,569,200,000
Annual Cost			
Sludge disposal cost	VND/year	5,395,000,000	4,431,000,000
Chemical cost (Polymer)	VND/year	3,917,000,000	3,566,000,000
Electric generation from digestion gas	VND/year	-	- 2,340,000,000
Income of CO_2 emission trading	VND/year	-	- 360,000,000
Cost value (Civil)	VND/year	8,110,000,000	16,347,000,000
(Mechanical and Electric)	VND/year	51,831,000,000	72,417,000,000
Total Annual Cost	VND/year	69,253,000,000	94,061,000,000

The cost in table is compared with reference to Case 1 cost.

The anaerobic digestion process is not recommended for this project for the following reasons.

- There is no economic incentive for use the digestion process because the electricity rate and sludge disposal costs are inexpensive in Viet Nam.

- Anaerobic digestion is difficult to operate properly because it has the potential of fire disaster.
- Anaerobic digestion increases influent BOD_5 and T-P (recycle flow from digestion and dewatering process) and results in additional treatment costs.

4.6.4 GHG Reduction by Treating Organic Compounds of Sewage at the STP

The effect of STP on GHG reduction is studied by comparing GHG emission from septic tank and from STP. The methodology of GHG reduction by treating organic compounds in STP is not defined. Therefore, the emission from septic tank is calculated by assuming that methane production form anaerobic lagoon for sewage is almost same as from septic tank because methane production from anaerobic lagoon is regulated by AM0013-Avoided methane emissions from organic sewage treatment. Methane emission from STP is calculated by USEPA data.

Baseline (Methane Emission from Septic Tank) (based on AM0013)

The baseline of treating organic compound of sewage is that sewage is treated by anaerobic lagoon.

Emission Amount of CH_4 (t) from river = Total COD $_{\text{available, m}}$ × B_0 × MCF $_{\text{baseline}}$ = 367 t CH_4/year

The parameter is as follows,

Total COD $_{\text{available, m}}$: 4,599 t COD (= 400mg/l × 31,500m^3/day × 365days/year/10^6)

B_0 : 0.21 t CH_4/t COD

MCF $_{\text{baseline}}$: 0.38 (average temperature: 28℃, average depth > 1m)

Project (Methane Emission from STP) (based on "Estimate of United State GHG Emissions from Wastewater" presented by USEPA)

Emission Amount of CH_4 (t) from STP = Population×BOD/capita×MCF×EF

= 188,000×0.2g/l×165 l/day×0.165×0.6×365days/year/10^6 = 224 t CH_4/year

The parameter is hypothecated as follows,

MCF : 16.5%

EF : 0.6 g as CH_4/g as BOD

Based on the calculation, the treatment by STP emissions 224 t as CH_4/year. The treatment by septic tank emissions 367 t as CH_4/year. Therefore, STP treatment emissions 60% of septic tank. However, actual CH_4 emission from the project without incineration could be high because estimation equation is based on the US data in which almost half of sludge treatment is incineration treatment producing less methane comparing to landfill disposal.

4.7 Priority Project I Components

Components of the proposed priority project I are presented in Table 4.7.1.

Table 4.7.1 Scope of the Priority Project I

Components	Unit	Quantity	Remarks
STP2	m^3/d	41,500	Tam Hiep Ward
Pumping Station	places	2	Thong Nhat Ward, STP2 Site
Manhole Type Pump Station	places	25	
Sewerage Facilities			
Main Trunk Sewer	km	12	D 200mm – 1500 mm
Branch Sewer	km	42	D 200mm – 280 mm
Tertiary Sewer	km	203	D 200mm
Interceptor pipe	km	6	D 100mm – 900 mm
Drainage Facilities			
Main Storm Sewer for Separate Area	km	45	D 600mm – 2000 mm, B 3000mm x H 3000mm
Main Storm Sewer for Combined Area	km	10	D 600mm – 2000 mm, B 2000mm x H 2000mm
Brunch Storm Sewer	km	111	D 500mm
Stream Improvement			
2.1 Bien Hung ditch with Gate	m	2,160	
3.2 Dien Hong ditch	m	370	
4.1 San Mau stream	m	3,650	
4.2 San Mau stream	m	2,480	
4.3 San Mau stream	m	390	
4.4 San Mau stream	m	610	
4.5 San Mau stream	m	1,310	
4.6 San Mau stream	m	720	
5.1 Linh Bayou	m	1,060	
6.1 Linh Bayou	m	1,150	
Linh Stream	m	1,150	
Procurement of O&M equipment	LS	1	High-Velocity Jet Truck, Vacuum Truck etc.

D: Diameter, B: Width, H: Height

4.8 Improvement of Sanitation Systems for Urban Areas not Served by Sewers

4.8.1 Septic Tank

A large percentage of the population in Bien Hoa City would be living outside the area serviced by the priority sewerage project and would continue to rely on septic tanks for sewage disposal. Householder's neglect is often a significant contributor to poorly performing systems that contribute high pollutant loads to the environment. By adopting a managed maintenance programmed for septic tanks, such poor performance may be prevented, and the system life extended significantly.

At present sludge removal is carried out by URENCO and private companies. Septic tank cleaning costs vary from VND 500,000 to VND 640,000 per visit depending on the service provider. These costs are about 0.6 % to 0.9 % of the average household annual income (average annual income 72 million to 84 million VND). Private companies are cheaper than URENCO therefore most people prefer to use private companies.

It is impossible to know how much sludge is actually collected in Bien Hoa because cleaning services are not regulated therefore there is no record keeping. Based on the household survey most owners only clean septic tanks when there is a problem such as an overflow or blockage.

Sludge collected by URENCO is treated at the landfill’s leachate treatment facility which consists of an upflow anaerobic sludge blanket and aerated fluidized bed reactor process. Private companies reportedly dispose sludge on their own privately managed lands. The level of environmental control is unknown but anecdotal evidence suggests that it is quite inadequate.

In the short term, the only way to implement regular cleaning and proper disposal of septic tank sludge is to make it mandatory and assign management responsibility to the public sewage management entity. In this section, the necessary number of suction trucks and personnel for regular cleaning is reviewed. Details of a septic tank management unit are presented in section 7 of the report that discusses organization for O&M.

(1) Legal Framework for Septic Tanks

There are no standards or regulations for the installation or maintenance of septic tanks in Viet Nam Decree 88/2007/ND-CP mentions that the Ministry of Construction (MOC) should promulgate regulations pertaining to wastewater discharged into urban and industrial park drainage system. In response to Decree 88, MOC issued Circular No 09/2009/TT-BXD which states that the discharge of household wastewater must comply with category C environmental standard TCVN 5945: 2005 for industrial water drainage issued by MONRE (Table 4.8.1). Category C requires a maximum BOD_5 of 100 mg/l which cannot be achieved if septic tanks are not cleaned on a regular basis to provide a suitable volume for hydrolysis of sludge particles.

Table 4.8.1 TCVN 5945: 2005 on Industrial Wastewater- Discharge Standard

No	Parameters and substances	Unit	Limitation values		
			A	B	C
1	Temperature	Celsius	40	40	45
2	pH value	-	6 – 9	5.5 – 9	5 – 9
3	Odor	-	Unobjectionable	Unobjectionable	
4	Color at pH=7	Co-Pt	20	50	-
5	BOD_5 at 20 Celsius	mg/l	30	50	100
6	COD_{Cr}	mg/l	50	80	400
7	Suspended solids	mg/l	50	100	200
8	Arsenic	mg/l	0.05	0.1	0.5
9	Mercury	mg/l	0.005	0.01	0.01
10	Lead	mg/l	0.1	0.5	1
11	Cadmium	mg/l	0.005	0.01	0.5
12	Chromium (VI)	mg/l	0.05	0.1	0.5
13	Chromium (III)	mg/l	0.2	1	2
14	Copper	mg/l	2	2	5
15	Zinc	mg/l	3	3	5
16	Nickel	mg/l	0.2	0.5	2
17	Manganese	mg/l	0.5	1	5
18	Iron	mg/l	1	5	10
19	Tin	mg/l	0.2	1	5
20	Cyanide	mg/l	0.07	0.1	0.2
21	Phenol	mg/l	0.1	0.5	1
22	Mineral oil and fat	mg/l	5	5	10
23	Animal-vegetable fat and oil	mg/l	10	20	30
24	Chlorine residual	mg/l	1	2	-
25	PCBs	mg/l	0.003	0.01	-
26	Pesticide: organic phosphorous	mg/l	0.3	1	
27	Pesticide: organic chlorine	mg/l	0.1	0.1	-
28	Sulfide	mg/l	0.2	0.5	1
29	Fluoride	mg/l	5	10	15
30	Chloride	mg/l	500	600	1000
31	Ammonia (as N)	mg/l	5	10	15
32	Total nitrogen	mg/l	15	30	60
33	Total phosphorous	mg/l	4	6	8
34	Coliform	MPN/100ml	3000	5000	-
35	Bioassay		90% of the test fish exposed to the concentration of 100% wastewater survive after 96 hours of constant exposure		-
36	Gross α activity	Bq/l	0.1	0.1	-
37	Gross β activity	Bq/l	1.0	1.0	-

Note: A: Discharge into the water bodies using for source of domestic water supply.
B: Discharge only into other water receiving bodies except the water bodies specified for Colum A.
C: Discharge into specific water bodies permitted by authority agencies (such as separate wastewater reservoir, sewer connecting to central wastewater treatment plant, etc..)

Source: TCVN 5945:2005

(2) Necessary Equipment of Cleaning Septic Tanks

The necessary number of vacuum suction trucks and staff required for cleaning septic tanks is estimated.

(2-1) Sludge production of Septic Tank

- Sludge production is estimated based on the following assumptions;
- Sludge accumulation rate is 0.04 m^3/capita/year (Source: Metcalf & Eddy, Water Use, 2006, Malaysia

Sewerage GidelineVol.5)

- Population of sewerage service area is 188,000.
- Population of Bien Hoa in 2020 is 830,000.

Based on the assumptions, sludge production is 25,680 m^3/year (= 0.04 × (830,000-188,000)) in areas outside the project service area.

(2-2) Volume of Sludge per day

Sludge volume is estimated on the following assumptions;

- Cleaning is carried out every two years.
- Cleaning is carried out 5 days a week.

The amount of sludge collected every day is 107 m^3/day (=25,680×2 / (5×4×12×2)).

(2-3) Number of Vacuum Suction Trucks and Staff

The estimation is conducted based on the following assumptions;

- The holding capacity of one truck is 10m^3/car.
- Two people are need to operate the truck and clean the tank.

For proper maintenance of septic tanks, 11 vacuum suction trucks (= 107 / 10) and 22 (= 107 / 10 × 2) staff are required.

4.8.2 Linh Stream

Linh stream flows adjacent to the site of STP2 site and has a very poor water quality compared to other streams in the area. Table 4.8.2 presents the comparisons of water quality between San Mau stream and Linh stream. Although the catchment area of Linh stream is smaller than that of San Mau Stream, Linh stream has BOD_5 that is about two times stronger than San Mau Stream.

Table 4.8.2 Water Qualities in Streams of Bien Hoa City

	BOD_5, mg/l	COD_{Cr}, mg/l	NH_3-N, mg/l	Coliform, MPN/100mL
San Mau Stream[1)]	74 - 257	184 - 456	16 - 48	5,232,500 - 30,075,000
Linh Stream[1)]	272 - 693	502 - 1,382	16 - 48	13,423,250 - 59,875,000

Source: 1) DONRE (2007 -2009)

Linh stream is outside the boundary of the priority area and almost half of it’s catchment basin, is located on the eastern side of National Road 1A, which is outside the service area for the priority project I. However, this stream will received effluent from STP2, and the bad water quality of Linh steam presents a negative image that would have a negative impact on people’s perception of STP operations and benefits. Therefore, the study team has investigated conditions in Linh stream to determine if anything could be done to improve the situation.

(1) Present Condition of Linh Stream

To study the present conditions of Linh stream, COD_{Mn} as permanganate is measured at various locations upstream and downstream.

Locations of sampling points are presented in Figure 4.8.1 and visual observation are provided in Figure 4.8.2. Sampling points No.4 and No. 5 are in the project's service area, and other points which are located in Long Binh ward (the eastern side of National Road 1A) are out of the project's service area.

Water in the upstream areas (point No.1) looks good and is used in a cultivated fish pond. However, at point No. 2 water quality starts to deteriorate, becomes grey and emits a slightly bad smell. At point No. 3, water in the stream is black and emits a strong bad smell. Water quality at point No. 4 appears to improve. Water quality at point No. 5 (near the site of STP No.2 highlighted in green) is the same as point No. 4.

Source: Google earth.com

Figure 4.8.1 Location and COD_{Mn} of Sampling Points in Linh Stream

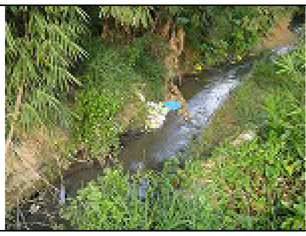
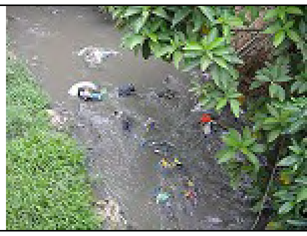
		
No 1 Point	No 2 Point	No 3 Point
		
No 4 Point (Wastewater from House Drain)	No 4 Point (Main Stream of Linh Stream)	No 5 STP Site

Figure 4.8.2 Photos of Sampling Points

Water quality ($COD_{Mn)}$ measured at each point confirms the visual observations. point No.1 is almost 0 mg/l, point No. 2 is 120 mg/l, point No.3 is over 250 mg/l, and points No.4 and No.5 are lower at 120 mg/l. Household sewage which has a COD_{Mn} of 60mg/l appears to be diluting the flow upstream of point No. 4.

Vietnamese water quality standards are based COD_{Cr} dichromate therefore the COD_{Mn} values measured by the Study Team are converted for comparison to the standard. According to data from the Japan Sewerage Agency, the COD_{Cr} as dichromate is 3.69 times as the COD_{Mn} value. Estimated values of COD_{Cr} are presented in Figure 4.8.3.

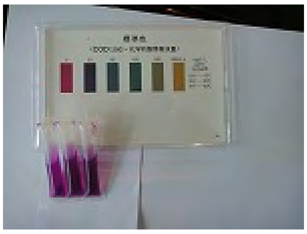
		
 COD_{Mn} = 0 mg/l Estimated COD_{Cr} = 0 mg/l	 COD_{Mn} = 120 mg/l Estimated COD_{Cr} = 440 mg/l	 COD_{Mn} > 250 mg/l Estimated COD_{Cr} > 920 mg/l
No 1 Point	No 2 Point	No 3 Point

Figure 4.8.3 (1) Water Quality of Sampling Points

		
 COD_{Mn} = 60 mg/l Estimated COD_{Cr} = 220 mg/l	 COD_{Mn} = 120 mg/l Estimated COD_{Cr} = 440 mg/l	 COD_{Mn} = 120 mg/l Estimated COD_{Cr} = 440 mg/l
No 4 Point (Sewage from House Drain)	No 4 Point (Main Stream of Linh Stream)	No 5 STP Site

Figure 4.8.3 (2) Water Quality of Sampling Points

Most of the pollution appears to be coming from the area highlighted in red on Figure 4.8.1 . The area is located in Long Binh ward between point No. 2 and No. 3.

The Study Team carried out a field survey of the suspect area and the following observations were made.

- About 390 households cultivate pigs, and total number of pigs is about 26,000 based on the information obtained during a meeting at the Long Binh ward office.
- Pig waste is discharged not only to the stream but also to street drains.
- Pig waste is discharged directly to streams without treatment at all the pig breeding houses visited by the JICA Study Team.
- According to the ward office, sewage from one beer factory and one hospital are also discharged untreated resulting in several complaints from residents. The JICA Study Team was unable to see this problem during the field survey.

		
Pig Farm	Sewage from pig farm running in a drainage	Drain gutter to the stream

Figure 4.8.4 Conditions in the Area between Point No 2 and No 3

(2) Legal Framework for Pig Breeding

(2-1) National Level

Based on the Circular No: 74/2003/TT-BNN issued by Ministry of Agriculture and Rural Development (MARD), pig breeding is classified as a commercial business when the scale of pig breeding meets one of the following two criteria (i) the annual average value of goods and services is more than VND 50 million or (ii) the number of pig is more than 100. Since the market price of a mature pig is generally more than VND 10 million, households having five pigs are classified as running a commercial business. When pig breeding is classified as a business, the following environmental protection measures based on National Technical Regulation No. QCVN 01-15: 2010/BNNPTNT dated 15 Jan 2010 by MARD must be followed:

a) Livestock farms are obligated to have a waste treatment system

b) Solid waste must be collected on a daily basis and treated by heat, chemical, or biological processes. Solid waste, prior to disposal, must be treated to ensure hygiene conditions in accordance with current regulations of veterinary medicine.

c) Liquid waste must be transmitted directly from livestock farms to treatment areas by a separate sewer pipe. Liquid waste shall be treated by chemical substance or by proper biological treatment methods. Treated sewage discharged to the environment must meet the following standard.

Table 4.8.3 Standard for Sewage from Pig Breeding Farms

No.	Criteria	Unit	Maximum Limit	Testing Method
1	Total Coliform	MPN/100 ml	5,000	TCVN 6187-1996 (ISO 9308-1990)
2	Fecal Coli	MPN/100 ml	500	TCVN 6187-1996 (ISO 9308-1990)
3	Salmonella	MPN/ 50 ml	KPH	SMEWW 9260B

Note: KPH – not detected

Source: National Technical Regulation No. QCVN 01-15: 2010/BNNPTNT

(2-2) Provincial Level

In January 2008, Dong Nai PPC issued Decision No 01/2008/QD- UBND outlining regulations for livestock farms within Dong Nai Province. According to the regulation livestock breeding is prohibited in areas within inner cities, inner towns, inner districts, urban areas, centralized residential zones, industrial zones, areas within boundary of schools, clinics and other public facilities. In essence pig breeding is not allowed in Bien Hoa City.

The decision identifies the Department of Agriculture and Rural Department (DARA), Department of Finance, Department of Planning and Investment, Department of Natural Resources and Environment as the responsible regulatory agencies. Table 4.8.4 presents the responsibilities of related departments. DARD is the department with overall responsibility for the monitoring of livestock breeding.

Table 4.8.4 Responsibilities of Related Department

Department	Responsibility
Department of Agriculture and Rural Development under PPC	1) To preside and coordinate with concerned departments and agencies to appraise projects on animal breeding development promotion zone planning of districts, towns to submit to provincial People's Committee for approval. 2) To coordinate with People's Committee's of districts, towns, cities and concerned departments and agencies to carry out the implementation of the zone planning, establishment of animal breeding development promotion zone 3) To inspect and urge local authorities, organizations,and individuals to implement this Regulation.
Department of Finance under PPC	1) To preside and coordinate with concerned departments and agencies to appraise the policy on expenditure support for animal breeding enterprises/establishments to relocate to animal breeding development promotion zone, and submit to provincial People's Committee for approval.
Department of Planning and Investment under PPC	1) To coordinate with concerned departments and agencies to appraise projects on animal breeding development promotion zone planning of districts, towns in accordance with the general development planning of province.
Department of Natural Resources and Environment under PPC	1) To coordinate with concerned departments and agencies to appraise projects on animal breeding development promotion zone planning of districts and towns, and to appraise projects on environmental protection, odor treatment, waste and wastewater treatment for ensuring that breeding does not cause environmental pollution in accordance with breeding scale in the animal breeding development promotion zone. 2) To coordinate with local authorities to define boundary of animal breeding prohibited area, boundary of animal breeding development promotion zone, and to define boundary of inner town, township, dense residential areas, industrial zones, public works, rivers, streams, lakes, dams, and domestic water pumping station for residential areas.
People's Committees at district level	1) Base on the local general planning and agriculture planning to build up the project on animal breeding development promotion zone planning to submit for approval as regulated. 2) To define boundary of animal breeding prohibited area, boundary of animal breeding development promotion zone, boundary of inner town, township, dense residential areas, industrial zones, public works, rivers, streams, lakes, dams, domestic water pumping station for residential areas. 3) To identify livestock/cattle, poultry structure, balance the proportion of land for breeding and cultivation in the planned zone for ensuring no environmental pollution. 4) To prepare planning for infrastructure such as traffic roads, electric power, water supply and drainage system in the animal breeding development promotion zone. 5) To announce to public the planning on animal breeding development promotion zone at People's Committee at commune level, where exists animal breeding development promotion zone planning; prepare propaganda plan for breeders/raisers' knowledge and consent to implement the planning.
People's Committees at commune level	1) To manage animal breeding enterprises/establishments within the planned animal breeding development promotion zone. 2) To inspect to make sure that no works and no facilities in the areas excepting for the planned areas for breeding development.
Breeding enterprises / establishments owners	1) To comply with the planning approved by competent State agencies in building up animal breeding enterprises. 2) To ensure that animal breeding facilities located in the planned area have epidemic hygiene measures, environmental protection measures, epidemic diseases safetymeasures in compliance with current regulations. must ensure. 3) To register the breeding facilities to the State management agencies in animal breeding development promotion zone on animal breeding location, types, origin of livestock/animal and commitments on epidemic diseases prevention, environmental sanitation and other relevant regulations.

Source: Decision No 01/2008/QD- UBND

At the city level, on 12th of February 2007 Bien Hoa CPC approved Decision No. 220/QD-UBND regarding the plan to cancel livestock breeding within city limits. In this plan the following activities would be prohibited in Bien Hoa City: (i) raising livestock at all household, livestock breeding farms, enterprises running livestock breeding, (ii) raising all kinds of livestock (pig, buffalo, cow, goat, etc), and (iii) raising livestock at all livestock breeding facilities (small, medium, big, scattered),. Decision No. 220 also noted that the policy supporting the relocation of those having livestock breeding facilities in Bien Hoa City will be finalized and approved later. However, until now the policy has not been prepared.

(3) Current Status of Pig Farms in Long Binh Ward

A survey by the People's Committee of Long Binh Ward in 2009, identified that there were more than 26,100 pigs in 390 pig breeding households located in residential areas even though pig breeding in residential areas is prohibited.. None of these households had a license or certificate related to their pig farm even though all breeding operations were large enough to be classified as a commercial business. Table 4.8.5 shows the average number of pigs per household in each residential area and Table 4.8.6 gives the distribution of households based on the average number of pigs.

Table 4.8.5 Number of Pigs per Household in Long Binh Ward, 2009

No.	Name of Residential Areas	Total No. of Household	Total No. of Pigs	Average No. of Pig per Household
1	Residential area 1	16	476	29.8
2	Residential area 2	199	15,547	78.1
3	Residential area 3	78	5,928	76.0
4	Residential area 5	20	1,020	51.0
5	Residential area 7	20	590	29.5
6	Residential area 8	57	2,585	45.4
	Total	390	26,146	67.0

Source: People's Committee of Long Binh Ward, 2009

Table 4.8.6 Number of Pig Raising Households Distributed according to Size for Long Binh Ward, 2009

No. of pigs raised per households	Total number of pig raising households	Percentage of pig raising households (%)
Less than 10	60	15.4
11-20	59	15.1
21-50	120	30.8
51-100	75	19.2
101-200	50	12.8
201-500	23	5.9
More than 501	3	0.8
Total	390	100.0

Source: People's Committee of Long Binh Ward, 2009

Although raising livestock is prohibited the pig breeding business is still active in Long Binh ward because the policy supporting the relocation of those having livestock breeding facilities has not yet been finalized and approved.

(4) Scope of Work for Linh Stream at the Detailed Design Stage

The PMU has identified the need to rehabilitate a section of Linh stream from Pham Van Thuan Street to the Cai river. Rehabilitation of Linh stream was not proposed in the F/S, however the PMU has requested that the JICA Study Team include it in the scope of the priority project I. In this section of the report the scope of work required at the detailed design stage is clarified.

The banks of Linh Stream near Pham Van Thuan Street are protected with concrete, but other banks near Cai River are unprotected. Runoff and stream flow erode soil banks and vegetation growing in soil banks make O&M works difficult. Therefore, it is necessary to protect banks with concrete to improve flow conditions and make it easier to maintain.

In some sections of the stream dwellings have encroached onto the maintenance right-of-way (ROW) and access to the stream for maintenance and construction is impossible.

At present, ROW boundaries have been decided and most of the households that must be relocated have received compensation. A few households have not yet agreed with the compensation price and negotiations are on-going. After completion of compensation and resettlement there should be no buildings within the RWO. Dong Nai PPC has put up bench marks to identify the boundaries of the ROW and based on these benchmarks site clearance has been carried out.

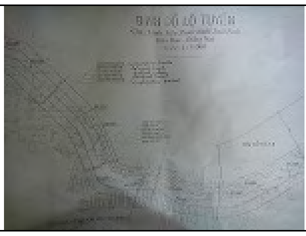
		
Concrete bank built near Pham Van Thuan Street	Bank without concrete protection	Bank without concrete protection near Cai River
		
Drawing presenting ROW boundaries	No buildings on the one side of bank according to ROW boundaries	Buildings set back from RWO boundaries
		
Bench Mark (white and red block) for ROW	Bench Mark (white and red block) for ROW	

Figure 4.8.5 Present Conditions along Linh Stream

The following work will be carried out at the detail design stage.

- Confirm the area required for construction of bank protection works
- Design the stream cross section and maintenance road based on the standards of Department of Construction.

CHAPTER 5 PRELIMINARY PLAN AND DESIGN OF THE SEWERAGE SYSTEM

5.1 General Layout Plan of the Sewerage System

STP2 is located at the east end of the priority area next to the Cai River. The priority area slopes gently toward the Dong Nai and Cai Rivers. Interceptor and main trunk sewer routes will be located along the two rivers to take maximum advantage of the slope. A number of roads in the project area have only been planned and are not yet constructed. This includes the road along the Cai River. The study team has confirmed the road construction schedule and has identified those that are suitable candidates for trunk sewers because they are expected to be constructed by 2015 (colored green in Figure 5.1.1). Roads that are not constructed before 2015 (colored orange in Figure 5.1.1) are not considered for sewer route selection.

Bien Hoa City PC is the executive agency of the construction of planned roads indicated in Figure 5.1.1. Small roads other than planned roads will be constructed by private developers who invest in developing the areas.

The general layout plan of the proposed sewerage system for the Priority Area is presented in Figure 5.1.2. Details of the sewer route plan are presented in Appendix 5-A.

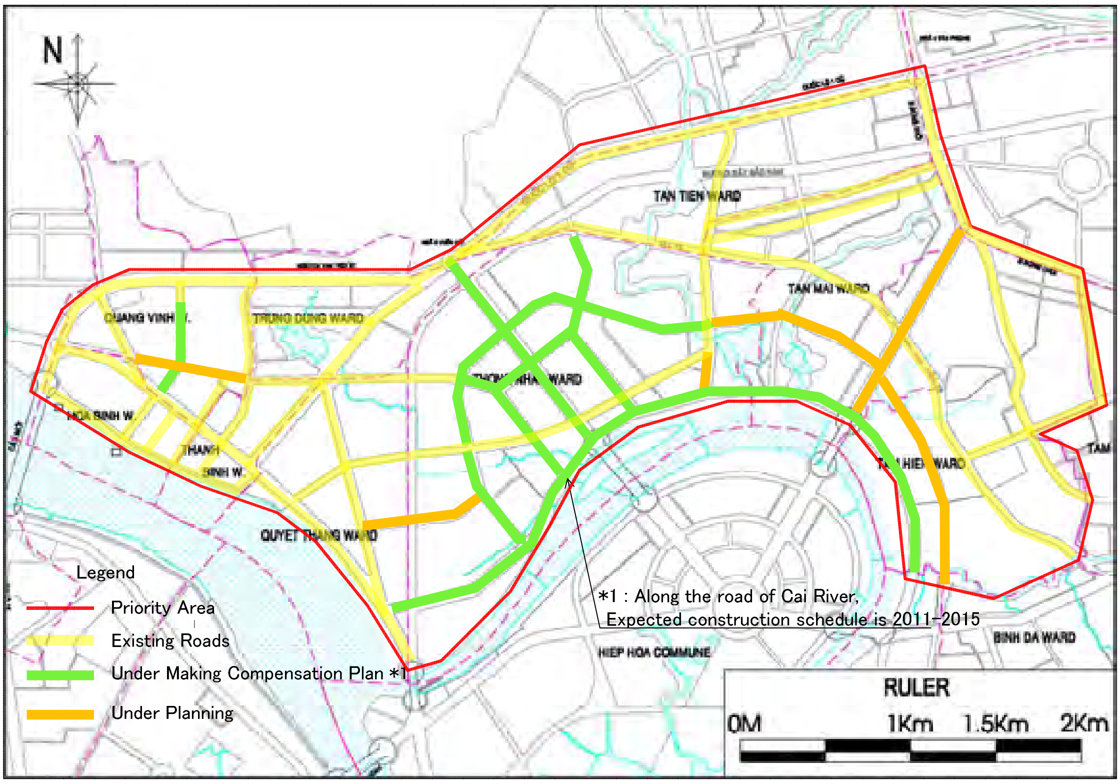
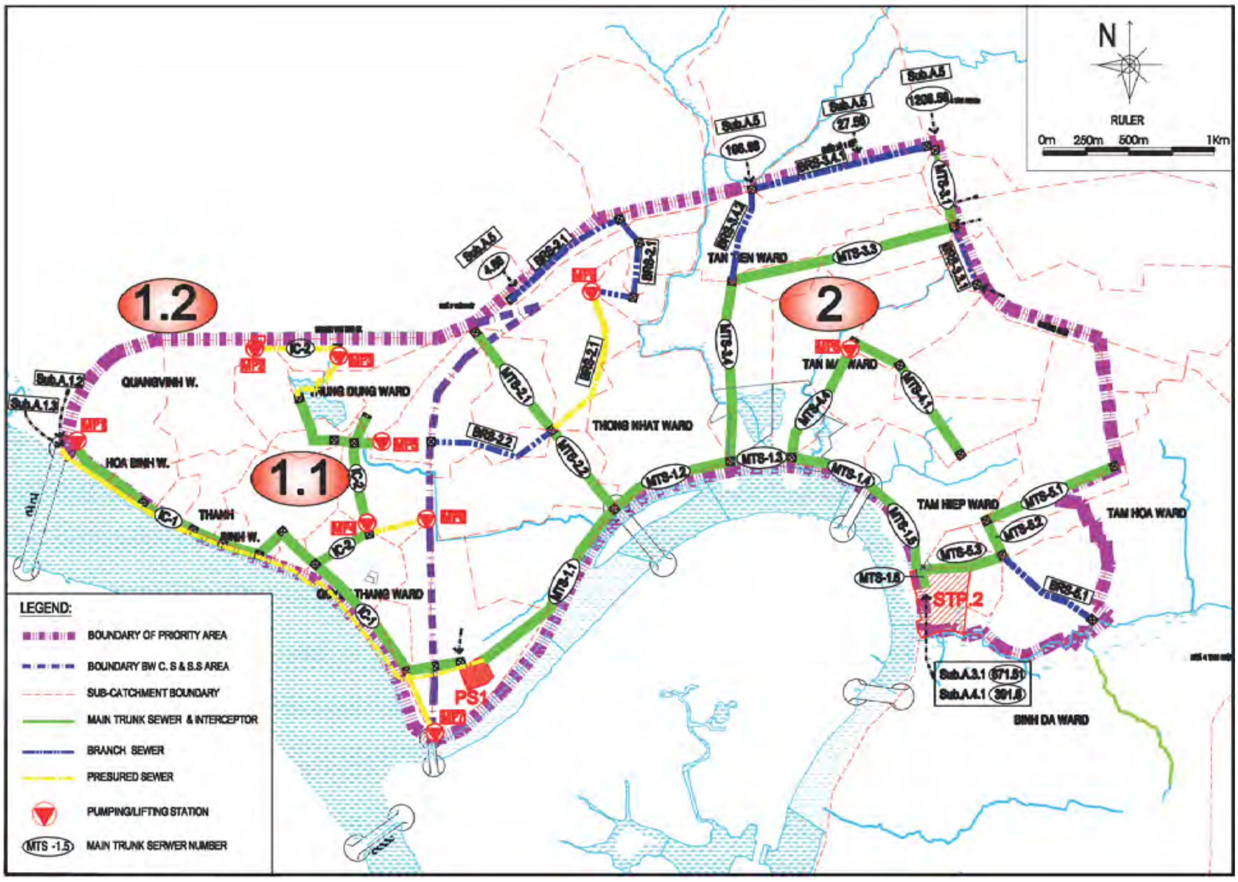


Figure 5.1.1 Status of Planned Roads



Note: Roads that are not constructed before 2015 (colored orange roads in Figure 5.1.1) are not considered for sewer route selection

Figure 5.1.2 General Layout Plan for Sewerage System

5.2 Sewage Collection Facility

5.2.1 Sewer Network

(1) Design Conditions and Criteria

Most of the design criteria are based on Vietnamese Standard – TCVN 7957:2008. Some design criteria which are not described in the Vietnamese Standard are proposed by the study team in consultation with the PMU.

1) Hydraulic Calculation

The manning formula is used for hydraulic calculation of gravity sewers, and Hazen William formula is adopted for pressure mains as follows:

Manning Formula

$$Q = A \times V, \quad V = 1/n \times R^{2/3} \times I^{1/2}$$

where, Q: Flow Rate (m^3/sec), V: Flow Velocity (m/sec), n: Roughness Coefficient, R: Hydraulic Radius (m), I : Hydraulic Gradient, A : Cross Section Area (m^2)

Roughness coefficients for different types of pipe materials are provided in Table 5.2.1.

Table 5.2.1 Coefficients for Sewer Design

Type of Sewer	n (Roughness Coefficient)
RC Pipe (Reinforced Concrete Pipe)	0.013
PVC Pipe	0.011
HDPE Pipe	0.011
Box Culvert (Concrete)	0.013
Open Channel (Concrete)	0.014

Source: Design Standard - TCVN 7957:2008, JICA Study Team

2) Flow Velocity

Minimum Velocity

Sewers must be designed to convey peak flow. In addition, the gradient of the sewer must be determined to ensure that the minimum flow velocity is maintained for each pipe diameter in order to keep the self-cleansing velocity at full flow. The minimum velocities are set according to Vietnamese Standard – TCVN 7957:2008 as follows;

Pipe Diameter (mm)	Minimum Velocity (m/sec)
150 – 200	0.7
300 – 400	0.8
400 – 500	0.9
600 – 800	1.0
900 – 1200	1.15
1300 – 1500	1.2
Over 1500	1.3

Maximum Velocity

The maximum velocities are set according to Vietnamese Standard – TCVN 7957:2008 as follow.

	Metallic Pipe	Non-metallic Pipe
- Sanitary Sewer	8.0 m/sec	4.0 m/sec
- Drainage Sewer	10.0 m/sec	7.0 m/sec

3) Hydraulic Capacity of Sewers

The hydraulic capacity of sewers are based on the full cross section of pipe for combined sewer and interceptor. The capacity of separate sewers is based on pipe size as follows:

・Diameter of 600 mm or less : Capacity is selected by approximately 200 % of the estimated flow

・Diameter of more than 600 mm : Capacity is selected by approximately 150 – 200 % of the estimated flow

4) Pipe Materials

The following materials are selected considering corrosion resistance and local availability.

Unplasticised Polyvinyl Chloride (PVC) pipe is normally used for small sanitary sewer, while High Density Polyethylene (HDPE) pipe is selected under soft soil condition.

Table 5.2.2 Pipe Materials

Diameter	Purpose	Pipe Material
Sanitary Sewer and Interceptor		
600 mm or less	Gravity Sewer	PVC Pipe, HDPE Pipe
700 to 1200 mm	Gravity Sewer	HDPE Pipe
More than 100 mm	Pressure Main	DI Pipe (Ductile Cast Iron Pipe)
Any diameter	Pipe Jacking	Reinforced Concrete Pipe
Storm Sewer		
2000 mm or less	Gravity Sewer	RC Pipe (Reinforced Concrete Pipe)

(2) Unit Sewage Flow

To calculate sewage flow into sewer, unit sewage flow per capita is used as calculated in Table 5.2.3

Table 5.2.3 Unit Sewage Flow per Capita in 2030

Combined System				
	Items	unit	Quantity	Remarks
(1)	Water Consumption	l/capita/day	165	
(2)	Sewage Ratio	%	80	
(3)	House Connection Ratio	%	100	
(4)	Domestic Sewage Flow	l/capita/day	132	(1)×(2)×(3)
(5)	Infiltration Ratio	l/capita/day	0	(4)×(0%)
(6)	Public Service Ratio	l/capita/day	13	(4)×(10%)
(7)	Small Industry	l/capita/day	13	(4)×(10%)
(8)	Total	l/capita/day	158	(4)+(5)+(6)+(7)
(9)	Total	l/capita/sec	0.001829	(8)/86,400
Separate System				
	Items	unit/ratio	Quantity	Remarks
(1)	Water Consumption	l/capita/day	165	
(2)	Sewage Ratio	%	80	
(3)	House Connection Ratio	%	100	
(4)	Domestic Sewage Flow	l/capita/day	132	(1)×(2)×(3)
(5)	Infiltration Ratio	l/capita/day	13	(4)×(10%)
(6)	Public Service Ratio	l/capita/day	13	(4)×(10%)
(7)	Small Industry	l/capita/day	13	(4)×(10%)
(8)	Total	l/capita/day	171	(4)+(5)+(6)+(7)
(9)	Total	l/capita/sec	0.001979	(8)/86,400

(3) Required Sewer

A breakdown of the length of the proposed interceptor and sanitary sewers by diameter and type of pipe is provided in Table 5.2.4.

Table 5.2.4 Lengths of Interceptor and Sanitary Sewer

Type of Pipe	Diameter (mm)	Interceptor (m)	Sanitary sewer (m)	Total (m)
DCIP	100	402	-	402
	150	785	-	785
	200	520	914	1,434
	Sub-total	1,707	914	2,621
PVC	200	293	204,497	204,790
	225	-	17,757	17,757
	250	-	15,876	15,876
	280	-	7,440	7,440
	400	-	632	632
	500	-	1,355	1,355
	630	-	556	556
	Sub-total	293	248,113	248,406
HDPE	250	485	-	485
	280	155	-	155
	315	385	-	385
	355	120	-	120
	450	923	-	923
	710	-	322	322
	800	-	140	140
	900	-	2,381	2,381
	1,200	-	1,214	1,214
	Sub-total	2,068	4,057	6,125
	900	2,227	2,259	4,486
	1,200	-	752	752
	1,500	-	1,462	1,462
	Sub-total	2,227	4,473	6,700
Total		6,295	257,557	263,852

(4) Overflow Chamber

Overflow chambers are constructed to intercept sewage from combined sewers. As all the outlets along the Dong Nai and Cai River are located under river high water level, flap gate would be installed to prevent back flow to interceptor sewer. Screen and sediment traps are also placed at overflow chambers to prevent blockage of the interceptor. A typical overflow chamber is shown Figure 5.2.1.

A total of 22 of overflow chambers are required in the combined system area. Details of each overflow chamber are shown in Appendix 5-D.

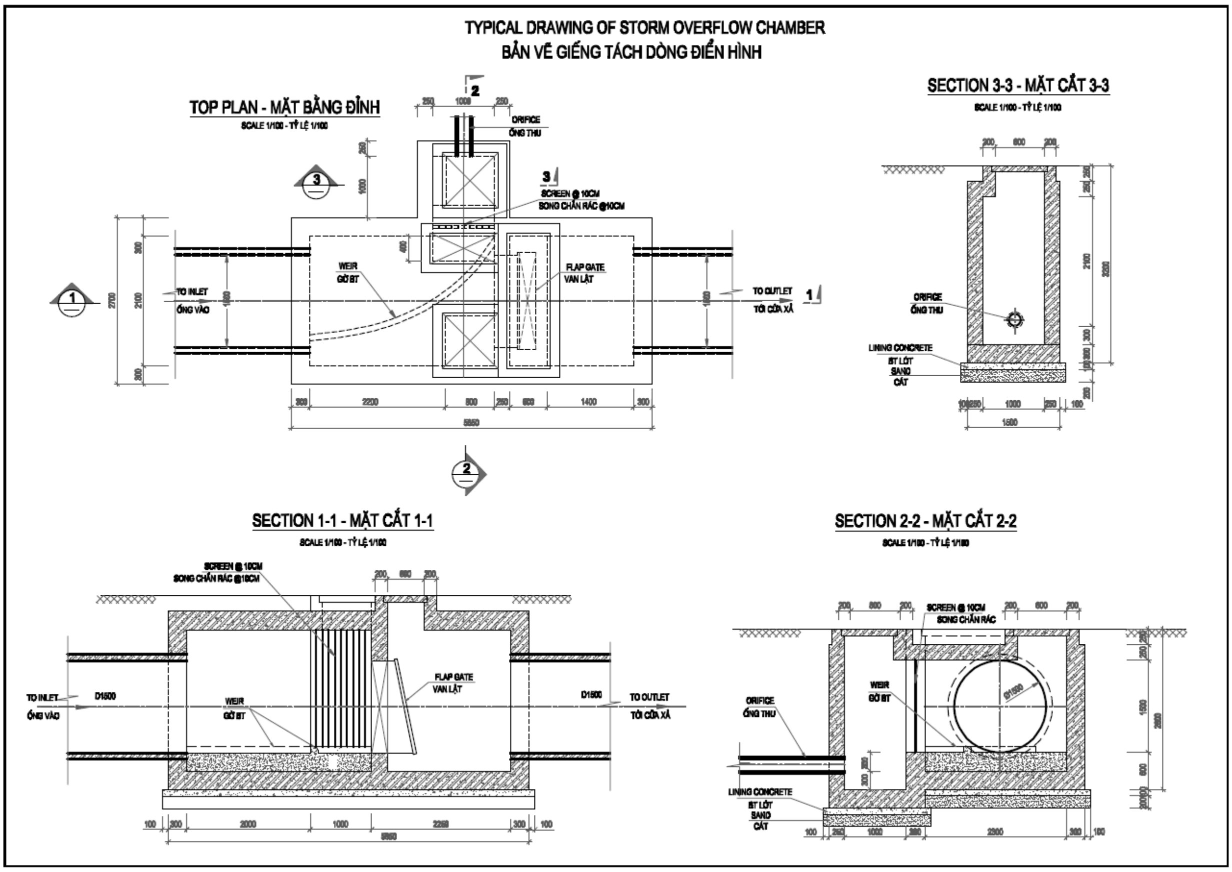
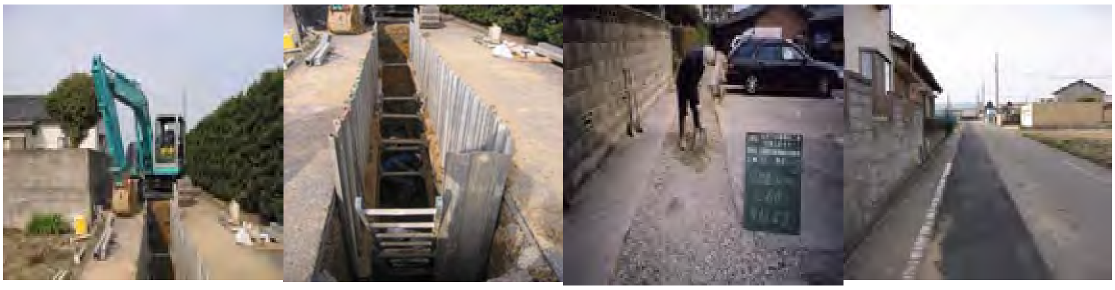


Figure 5.2.1 Typical Overflow Chamber

(5) Sewer Construction Method

There are two typical construction methods for sewer installation as shown in the following photographs, namely open cut method and pipe jacking method.

<Open Cut Method>



<Pipe Jacking Method>

Pipe jacking method is recommended for the following conditions;

- Railway, and large river and canal crossings
- Roads with heavy traffic
- Deep sewers

According to road conditions, pipe jacking method is recommended for trunk sewer alignments indicated in Figure 5.2.2.

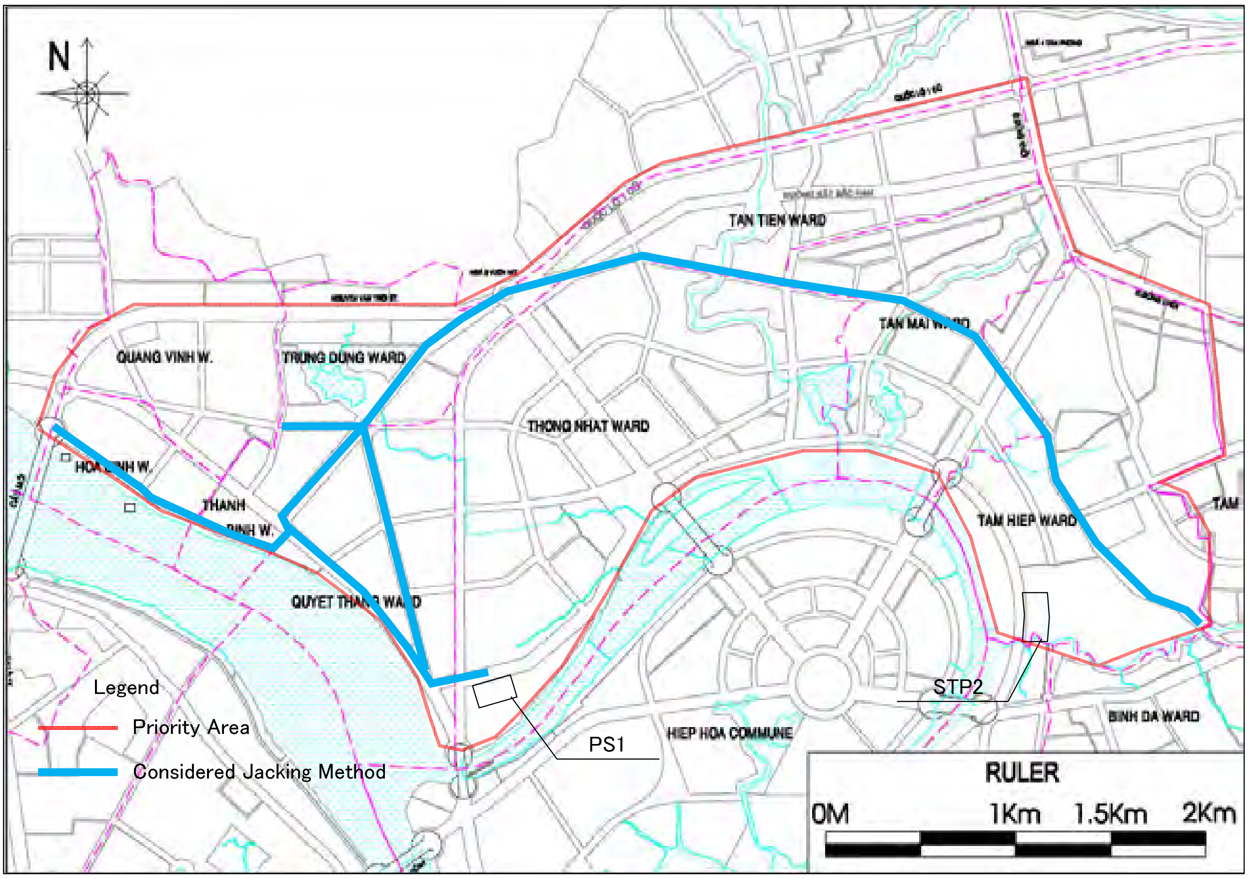


Figure 5.2.2 Trunk Sewer Alignments Using Pipe Jacking Method

5.2.2 Pumping Stations

(1) Type of Pumping Stations

Pumping stations are required to lift or convey sewage when gravity flow is no longer feasible.

There are two types of Pumping Stations;

- Main pumping stations (with building) with capacity greater than 8.0 m^3/min
- Manhole type pumping stations (MTP; self-contained under ground) with capacity of 8.0 m^3/min or less

(2) Basic Design of Main Pumping Stations

Two main pumping stations are proposed in Priority Area as shown in Table 5.2.5. PS 5 is located at the treatment plant.

Table 5.2.5 Design Maximum Flow of Main Pumping Stations

Item No.	Design Maximum Flow (Peak Flow)	Remarks
PS 1	24,800 m^3/day (17.22 m^3/min)	Combined Sewer System (including storm water)
PS 5	Total : 128,100 m^3/day (88.96 m^3/min) For STP2 : 72,800 m^3/day (50.55 m^3/min)	Excess flow is pumped to STP3 in future.

1) Main Facilities at Pumping Stations

Main pumping stations are designed with the following features for trouble free operation:

- Multiple pump units with a similar pumping capacity at each station
- Facilities to protect pumps against damage
- Odor control
- A standby power generator

2) Pump Capacity

Pumping stations are designed with multiple units of the same capacity to simplify maintenance, reduce spare parts and even keep a spare pump.

Table 5.2.6 Pump Capacity of PS1 and PS5

Item No.	Design Maximum Flow	Number of Pump	Capacity	Remark
PS 1	Peak flow 17.22 m^3/min	8.7 m^3/min×4 (Pump Head = 12m)	Normal 17.4 m^3/min (8.7 m^3/day×2)	2 duty, 2 Stand-by
PS 5	Peak flow 50.55 m^3/min	16.9 m^3/min×5 (Pump Head = 16m)	Normal 50.7 m^3/min (16.9 m^3/day×3)	3 duty, 2 Stand-by

3) Pump Protection

The pumping station is provided with the following facilities and equipment to protect the pumps from solids, debris and grit.

- Manual Coarse Screen
- Automatic Fine Screen
- Grit Chamber

4) Odor Control

The main pumping stations are designed with activated carbon adsorption systems to protect residents from bad smells. Activated carbon is selected for the following reasons.

- The area requiring odor control is very small (screening an grit removal storage area and wet well)
- The activated carbon adsorption process is effective for a large range of odor intensities.
- The maintenance of activated carbon adsorption systems is simple.

Screenings and grit removed from pumping stations typically have a very strong odor because they are septic. These will be kept in a separate room to contain the odor and the room will be accessible to waste collection vehicles.

5) Standby Power Supply

Power failures in Bien Hoa City are frequent (see.5.3.1(4)). The pumping station is provided with power generator to allow continuous operation during power failure as same as STP.

6) Size of the Pumping Station Building

In general the size of the pumping station is decided by the layout of the basement floor. where gates, channels, pumps and other facilities are located. The electrical room, generator room, odor control room and garage are arranged at ground floor which is above the flood level at the site.

The basement floor for PS 1 is shown in Figure 5.2.3. The building covers an area of 314 m^2

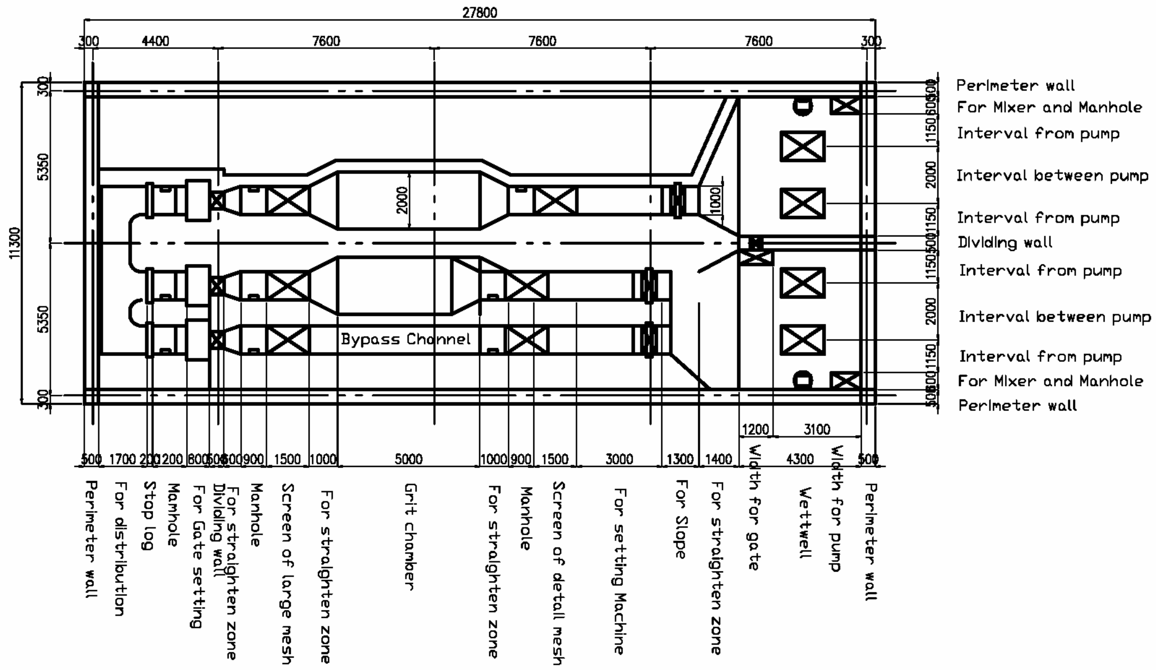


Figure 5.2.3 Basement Floor for PS 1

The basement floor for PS5 is shown in Figure 5.2.4. The building covers an area of 681 m^2

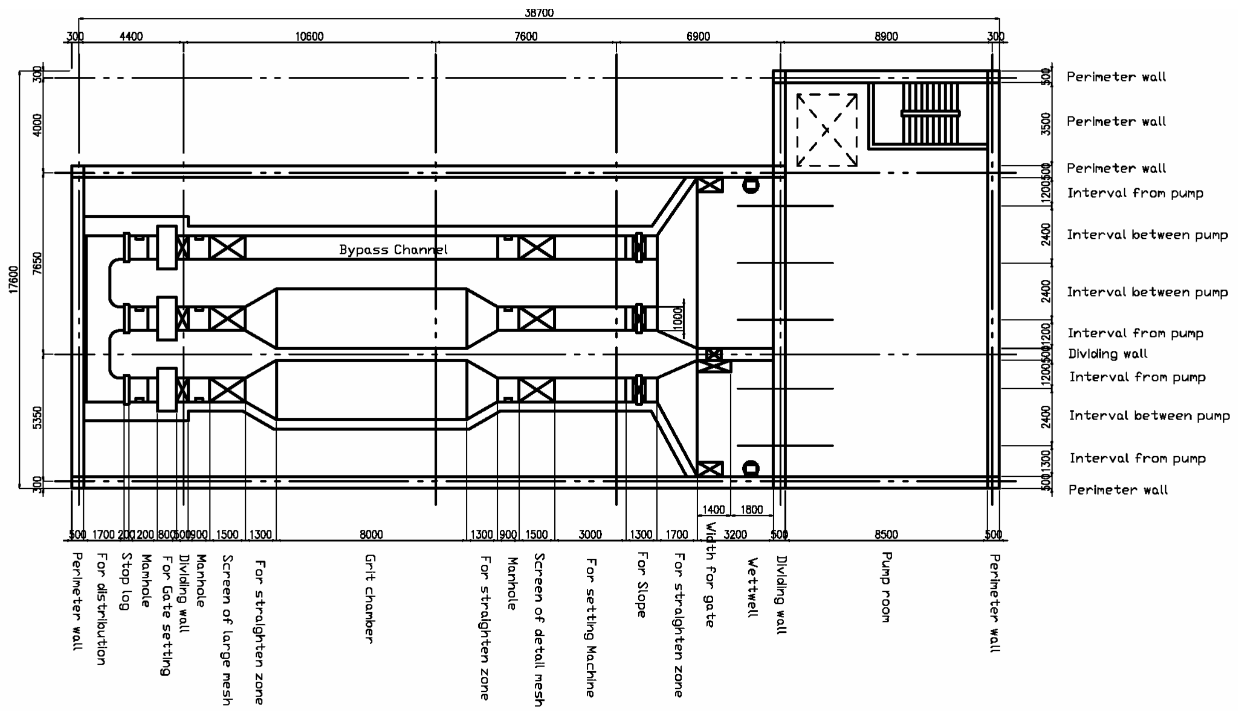


Figure 5.2.4 Basement Floor for PS 5

7) Buffer Zone for Pumping Stations

The buffer zone for pumping stations is in accordance with National Technical Regulation on Domestic Wastewater (QCVN-07:2010/BXD) shown in Table 5.2.7.

Table 5.2.7 National Technical Regulation on Domestic Wastewater

No.	Items	Buffer zone (m) base on capacity (× 1000m^3/day)			
		< 0.2	0.2 - 5	5 - 50	>50
1.	Pumping Station	15	20	25	30
2.	Wastewater treatment plant				
a.	Physical treatment (combine with Sludge drying bed)	100	200	300	400
b.	Biological treatment (combine with Sludge drying bed)	100	150	300	400
c.	Biological treatment without Sludge drying bed (combine with Sludge drying equipment, Sludge treated equipment)	10	15	30	40
d.	Underground sewage filter yard	100	150	300	500
e.	Sewage farming	50	200	400	1,000
f.	Biological pond	50	200		
g.	Sewage Oxidation channel	50	150		

The capacity of PS 1 is 24,800m^3/day therefore the width of the buffer zone is 25m. PS5 is located at the treatment plant with a buffer zone of 40m which is greater than the buffer zone specified for pumping stations.

8) Layout Plan of PS 1

The Layout Plan for PS 1 is shows the main building, turning space for maintenance truck and buffer zone. The turning space is used to enter the garage to remove screenings and grit and to renew the activated carbon cartridge. The layout plan of PS 1 is presented in Figure 5.2.5. The layout plan for PS 5 is presented in Figure 5.3.4 showing it’s location within the STP site.

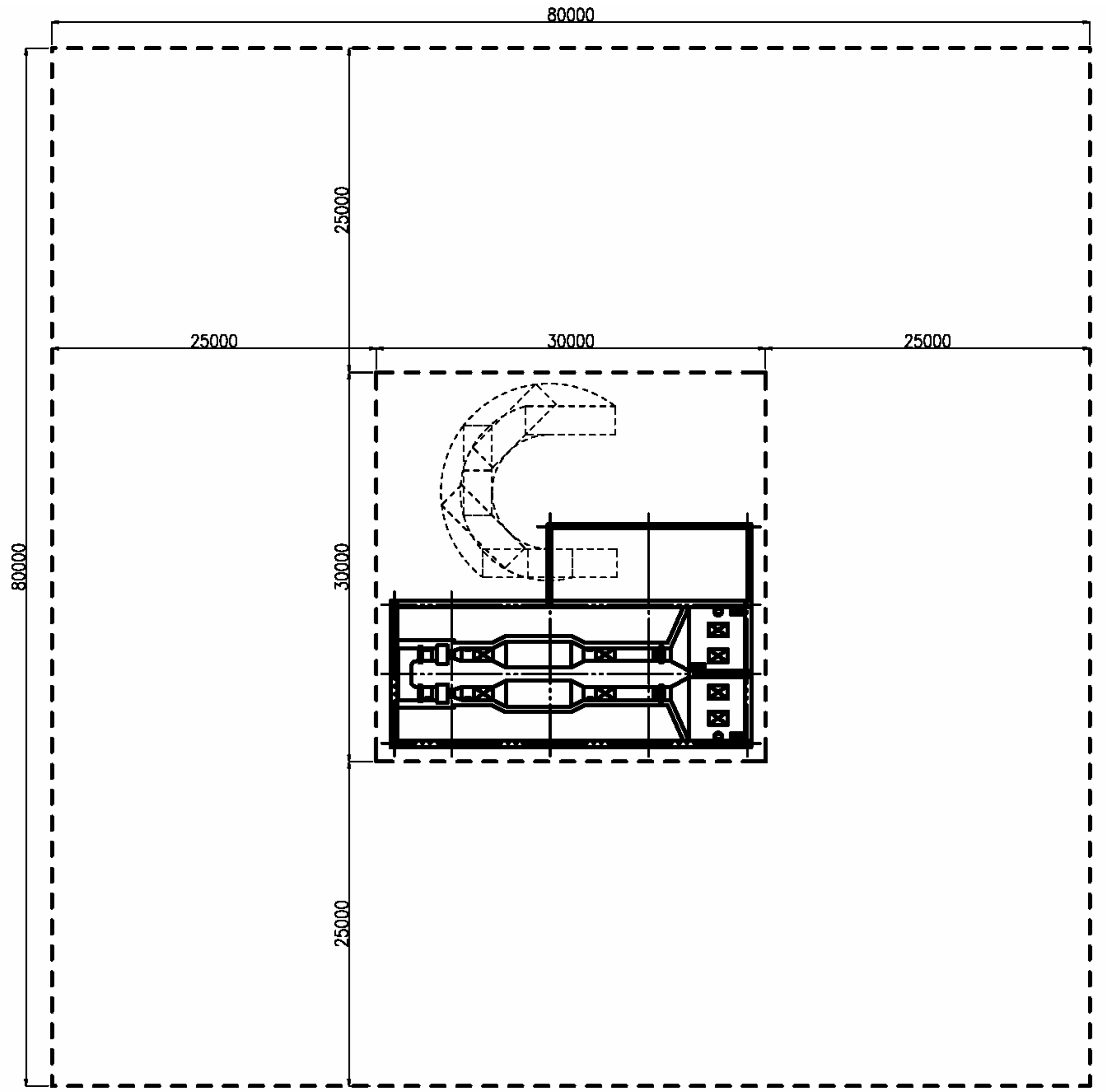


Figure 5.2.5 Required Area of PS 1

(3) Manhole Type Pumping Station (MTP)

MTP is a small-scaled pumping station where the pump equipment is located inside a manhole. MTP can usually be constructed within the road allowance therefore land acquisition is often not necessary. The only equipment installed above the ground is the control panel and electrical service as shown in Figure 5.2.6 and 5.2.7. Generally MTP is used to collect sewage from small low lying residential pockets that cannot be serviced by gravity. The amounts of sewage are small (not more than 8.0 m^3/min approximately) and the flow can be handled with small submersible pumps dia.200mm×3 no. or dia.150mm×4 no.. The some mobile power generators are prepared at STP2 in case of power failure for manhole type pumping stations.

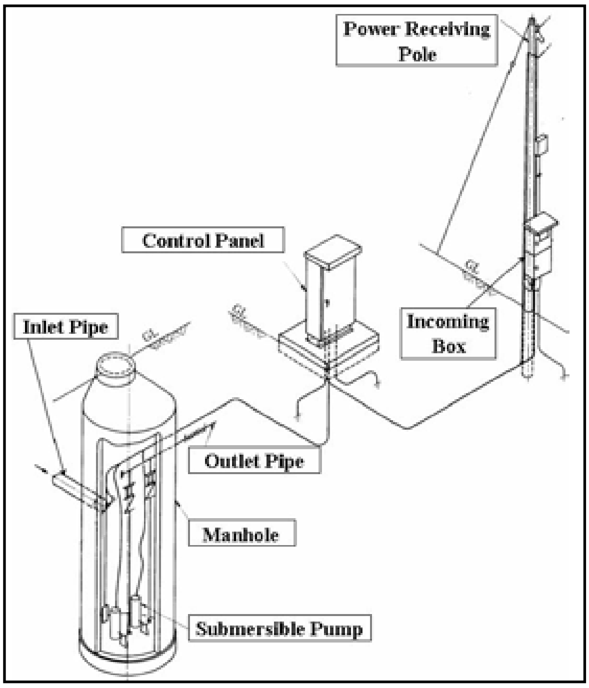


Figure 5.2.6 Components of MTP

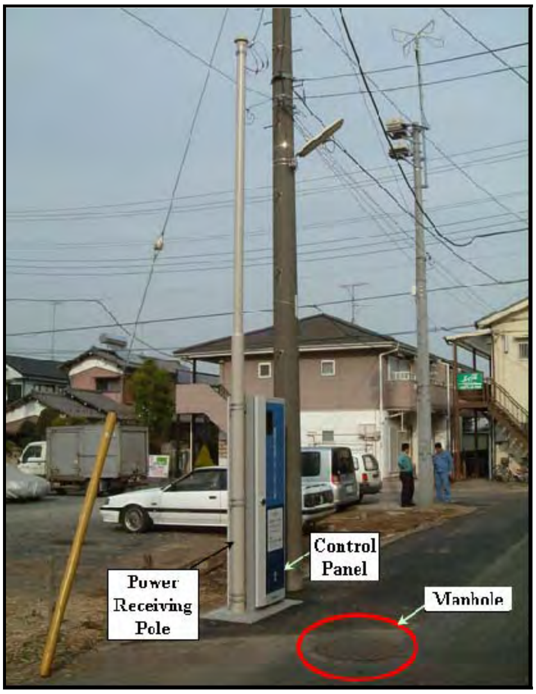


Figure 5.2.7 Photo of MTP

The total number of MTP is 25 sets in the Priority Area. The summary of MTP is shown in Table 5.2.8.

Table 5.2.8 Summary of MTP

Item No.	Design Maximum Flow	Number of Pumps	Remark
MTP-1	1.84 m^3/min	1.9 m^3/min×2 (Pump Head = 6m)	1 duty, 1 Stand-by
MTP-2	1.66 m^3/min	1.7 m^3/min×2 (Pump Head = 18m)	1 duty, 1 Standby
MTP-3	2.51 m^3/min	2.6 m^3/min×2 (Pump Head = 10m)	1 duty, 1 Standby
MTP-4	5.76 m^3/min	5.8 m^3/min×2 (Pump Head = 7m)	1 duty, 1 Standby
MTP-5	0.91 m^3/min	1.0 m^3/min×2 (Pump Head = 5m)	1 duty, 1 Standby
MTP-6	1.29 m^3/min	1.3 m^3/min×2 (Pump Head = 9m)	1 duty, 1 Standby
MTP-7	0.22 m^3/min	0.3 m^3/min×2 (Pump Head = 8m)	1 duty, 1 Standby
MTP-8	2.98 m^3/min	3.0 m^3/min×2 (Pump Head = 7m)	1 duty, 1 Standby
MTP-9	2.00 m^3/min	2.0 m^3/min×2 (Pump Head = 17m)	1 duty, 1 Standby
MTP-10-25	0.64 m^3/min	0.7 m^3/min×2 (Pump Head = 5m)	1 duty, 1 Standby

(4) Screenings and Grit Disposal

The screenings and grit from pump stations and interceptor diversion chambers is treated as follows.

1) Main Pumping Stations

Large screenings over about 10cm size are removed by hand and transferred to landfill site. The grit and small screenings under 10cm size are removed by machine, washed and separated in the building, finally transferred to landfill site with container.

2) MTS

The screenings over about 40mm are removed by mesh basket. The baskets have to be cleaned often and the screenings transferred to STP2. Grit and smaller solids less than 40mm are pumped with the sewage. The solids are kept in suspension by a specially designed bottom that swirls the flow near the pump intake.

3) Overflow Chambers

Solids over 100mm size are removed by coarse mesh screen place before the entrance to the interceptor pipe. The mesh is cleaned daily and the screenings are transferred to STP2.

5.3 Sewage Treatment Plant

5.3.1 Design Conditions for STP2

The following five conditions are considered in preparing a preliminary design of STP2 for cost estimating purposes.

- Receiving Stream Level
- Land formation level
- Soil conditions
- Electric power supply conditions and need for stand-by power
- Treatment of sludge from septic tanks

(1) Receiving Stream Levels

Effluent from STP2 is discharged to Linh Stream which has the same high water level as the Cai River and Dong Nai River. The F/S and EIA Reports provides the following information on water levels.

- The highest water level is +2.19 m (year 2000)
- The lowest water level is -2.06 m (year 1983)
- The average highest water level is +1.59 m
- The average lowest water level is -1.79 m
- The average water level difference is 3.38 m
- The design water level in the F/S is +1.84 ~ 1.94 m

The study team has used the highest water of +2.19 m for design of the treatment works.

(2) Land Formation Level

Current ground levels at the site of STP2 are as follows.

- Land : approximately +1.0 ~ +2.5 m (average +1.5m)
- Ponds : approximately -0.1 ~ -0.5 m (average -0.30m)

The planed formation level for STP2 is set to +3.6m which is the same level identified for the Cai River road in basic design documents. This level is higher than the highest water level of +2.19m.

It will be necessary to raise existing ground levels by about 2 m and about 4 m from the bottom of the existing ponds.

(3) Soil Conditions

JICA Study Team carried out geotechnical investigation at six points within the site of STP2. Results are as follows.

- The thickness of top soil is 0.6 ~ 1.8 m.
- The depth of the bearing layer is approximate 9 ~ 14 m from the formation level of the site.
- The bearing layer consists of rock and silt. The N value of silt is more than 20.
- The middle layer consists mostly of cohesive soil. The N values for cohesive soil are between 3 and 10.

The location of boreholes is shown in Figure 5.3.1.

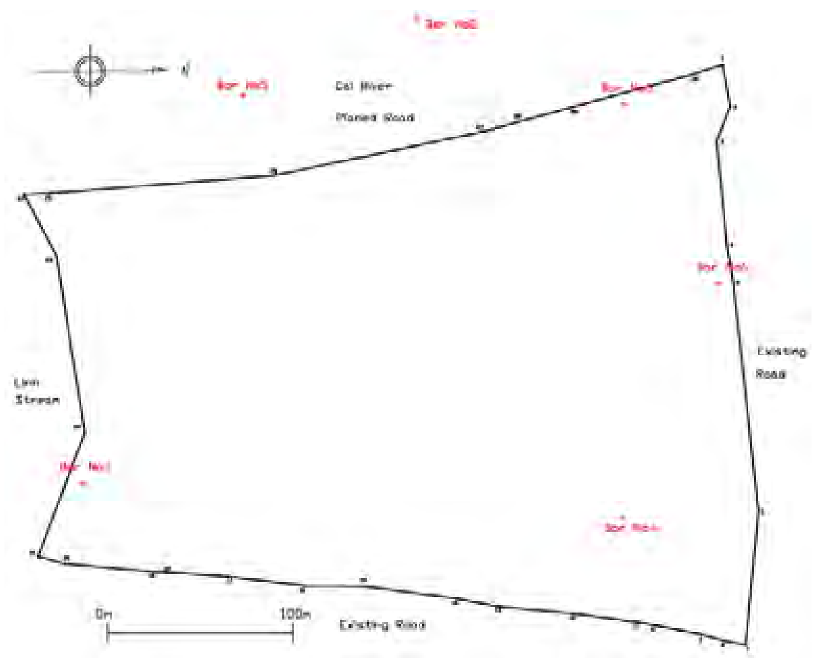


Figure 5.3.1 Location of Boreholes at STP2

The vertical relation between bearing layer and proposed structure levels is presented in Figure 5.3.2.

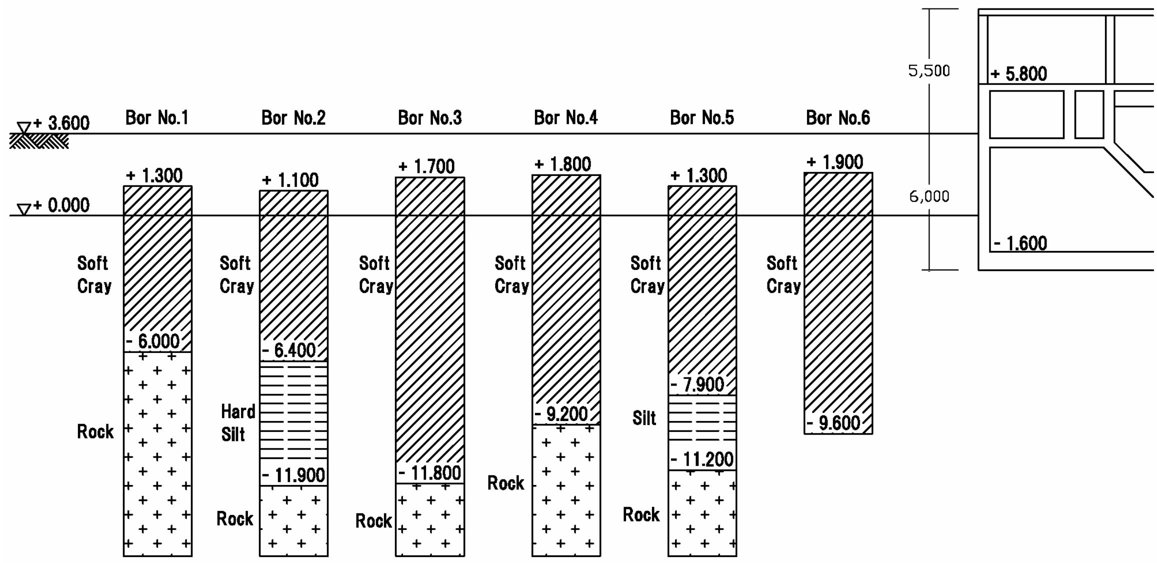


Figure 5.3.2 Positional Relation between Bearing Layer and Structure

Taking the above soil conditions into account, soil improvement or pile works are required for the constructions of STP2, because the basement of the structures can not reach to the bearing layer.

(4) Electric Power Supply Conditions and Need for Power Generator

The total power failure in Bien Hoa City during January 2007 to December 2010 is shown in the Figure 5.3.3. The figure shows that power failures lasting more than six hours occur frequently each year.

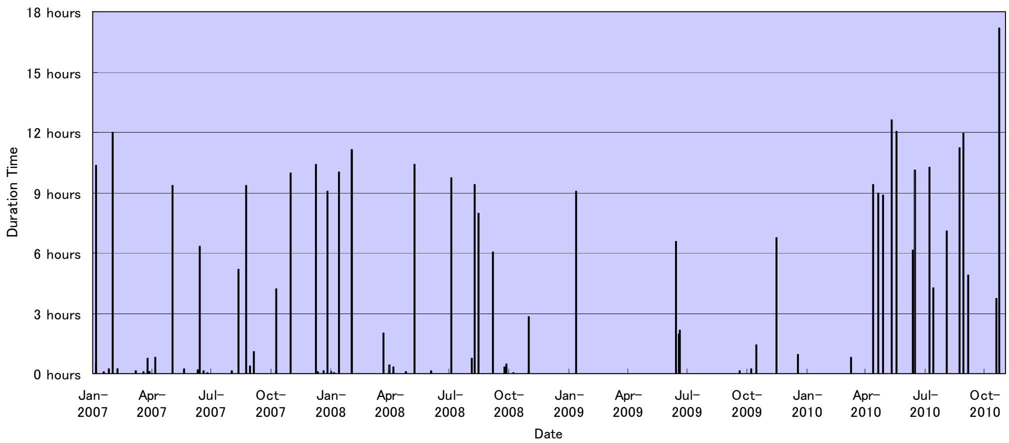


Figure 5.3.3 Power Failure Events in Bien Hoa for the Period 2007-2010 (Source: PMU)

Power failures are related to equipment inspection and problems including power shortages. A total of 97 power failures occurred during four years. The number of power failures related to planned equipment inspection was 70 (about 70% of the total). Remaining power failures were unplanned and included 11 failures that lasted over six hours. The average duration of unplanned power failures was 4 hours and 24 minutes. In Japan a standby generator is generally required when power failures last longer than six hours. Therefore, power generators are included in the design of STP2 and Main Pumping Stations.

Table 5.3.1 Number of Unplanned Power Failure Events during the 2007-2010 Period in Bien Hoa City

	Date	Start	End	Duration time
1	2007/1/6	13:10	13:30	0:20
2	2007/1/17	19:22	19:25	0:03
3	2007/1/25	8:07	8:21	0:14
4	2007/3/25	12:03	12:08	0:05
5	2007/5/21	15:00	15:15	0:15
6	2007/5/21	15:42	15:52	0:10
7	2007/6/26	13:40	13:44	0:04
8	2007/8/1	21:02	21:07	0:05
9	2007/8/12	8:18	13:28	5:10
10	2007/8/24	12:40	12:43	0:03
11	2008/7/4	10:06	19:50	9:44
12	2008/8/15	8:20	16:18	7:58
13	2008/9/5	7:56	14:00	6:04
14	2008/9/23	9:55	10:14	0:19
15	2008/9/26	9:45	10:15	0:30
16	2008/9/27	9:50	10:10	0:20
17	2009/10/14	22:20	23:45	1:25
18	2009/11/15	7:27	14:12	6:45
19	2009/12/17	15:06	16:03	0:57
20	2010/4/20	8:03	17:03	9:00
21	2010/4/27	8:04	16:57	8:53
22	2010/5/11	6:00	18:37	12:37
23	2010/6/12	12:20	18:30	6:10
24	2010/6/15	8:11	18:19	10:08
25	2010/7/8	10:20	20:37	10:17
26	2010/7/13	7:59	12:14	4:15
27	2010/10/22	6:50	0:00	17:10
	Maximum			17:10
	Average			4:24

Source: PMU

(5) Treatment of Sludge from Septic Tank

The sludge collected from septic tanks is disposed at the Trang Dai Landfill Site. There is no defined standard or regulation for the disposal of sludge from septic tank because it is classified as solid waste. Septic tank sludge is difficult to treat at the landfill site because septic sludge has high ammoniac nitrogen and phosphorus. Therefore the study team proposes that septic tank sludge should be treated at the STP.

The discharge of septic tank sludge at the STP 2 creates some additional concerns for the stability of the treatment process.

- The pollutant load from septic tank waste is more concentrated than sewage, especially the nitrogen content.
- The addition of large volume of septic tank waste can cause an increase in chromaticity levels.

According to articles published in the Monthly Journal of Sewerage in Japan, there is usually no negative impacts on the treatment process if the volume of septic tank waste is less than 1.0% of the total volume of sewage.

The study team does not expect any problems at STP2 because the volume of septic tank waste is about 0.34% of daily average sewage flow in 2020 (=107 m^3/day of sludge volume / 31,500 m^3/day of wastewater volume x 100).

5.3.2 Design Criteria for STP

(1) Unit Process Design

The design criteria selected for STP2 are shown in Table 5.3.2. They are based on Japanese and Vietnamese standards.

Table 5.3.2 STP Design Criteria

Item		Unit	Design Criteria	Selected value
1.	Grit Chamber			
(1)	Overflow Rate	m^3/m^2/day	1,800	1,800
(2)	Maximum Velocity	m/sec	0.3	0.3
2.	Primary Sedimentation Tank			
(1)	Overflow Load	m^3/m^2/day	25 - 70	50
(2)	Water Depth	m	2.5 - 4.0	3.5
3.	Reactor Tank			
(1)	Water Depth	m	4.0 - 6.0	5.5
(2)	Hydraulic Retention Time (HRT)	hour	6.0 - 8.0	8.0
4.	Final Sedimentation Tank			
(1)	Overflow rate	m^3/m^2/day	20 - 30	25
(2)	Water Depth	m	2.5 - 4.0	3.5
5.	Gravity Thickener			
(1)	Solids Loading	kg/m^2/day	60 – 90	60
(2)	Water Depth	m	Approx. 4.0	4.0

(2) Effluent Water Quality Criteria

Effluent quality for the STP is discussed in Chapter 4 of the report and key parameters that affect process design are shown in Table 5.3.3.

Table 5.3.3 Proposed Effluent Water Quality from STP

Item	Unit	Criteria
BOD_5	mg/l	30
SS	mg/l	50
NO_3-N	mg/l	30
NH_4^+-N	mg/l	5
PO_4^{-3}-P	mg/l	6
Total Coliforms	MPN/100 ml	3,000

Note: Criteria based on regulation QCVN14-2008/BTNMT

5.3.3 Site Plan and General Layout of Unit Processes

STP2 is located on the site of an existing fish farm. The access road to STP2 is about 4.5 m wide at its most narrow point. The City plans to build a new road (Cai river road) and this new road would be used to access STP2 in the future.


Existing access road near the main street


Existing access road near STP2

Outline of STP2 is as follows.

Location :	Tam Hiep Ward
Area :	9.34 ha
Present Land Use :	Fish Farm
Capacity :	52,000 m^3/day (Phase 1)
Sewage Treatment Methods:	Conventional Activated Sludge (CAS)
Discharge Point:	Linh Stream (Connected to Cai river)

Fish Farm (STP2 site)

Linh Stream

Main facilities and unit processes are shown in Table 5.3.4 and the site layout plan is presented in Figure 5.3.4 showing the boundaries and the layout of proposed STP2 with the conventional activated sludge process. The buffer zone is meant to prevent nuisance odors and noise to nearby residents. The buildings and facilities involved in sewage treatment cannot be located within the buffer zone. However, th administration building can be located inside the buffer zone because it is not a treatment facility.

Table 5.3.4 Main Facilities and Unit Processes for STP2

ID	Facility	Unit Process	Q'ty
(1)	Main Pumping Station (including Grit Chamber)	Screening, grit removal and pumping	1
(2)	Distribution Tank	Flow rate control for each	1
(3)	Primary Sedimentation Tank	Settling of biomass	4(16)*
(4)	Reactor Tank	Aeration and mixing for conversion to biomass	4(8)*
(5)	Final Sedimentation Tank	Settling of biomass	4(16)*
(6)	Disinfection Tank	Removal of pathogens by ultraviolet radiation	1
(7)	Blower Room	Generation of air for reactor tank	1
(8)	Gravity Thickener	Concentrating sludge by gravity to reduce volume	4
(9)	Sludge Pump Room	Transfer concentrated sludge to Sludge treatment building	1
(10)	Sludge Treatment Building	Sludge Dewatering Unit, Sludge Storage Tank, Electric Power Generator Unit, Odor control Unit	1
(11)	Administration Building	Offices, process laboratory, electrical room, controls	1
(12)	Workshop	Repair equipment, storage	1
(13)	Garage	Parking space of vehicle for maintenance work	1

*4 (16) = 4 process streams and 16 tanks

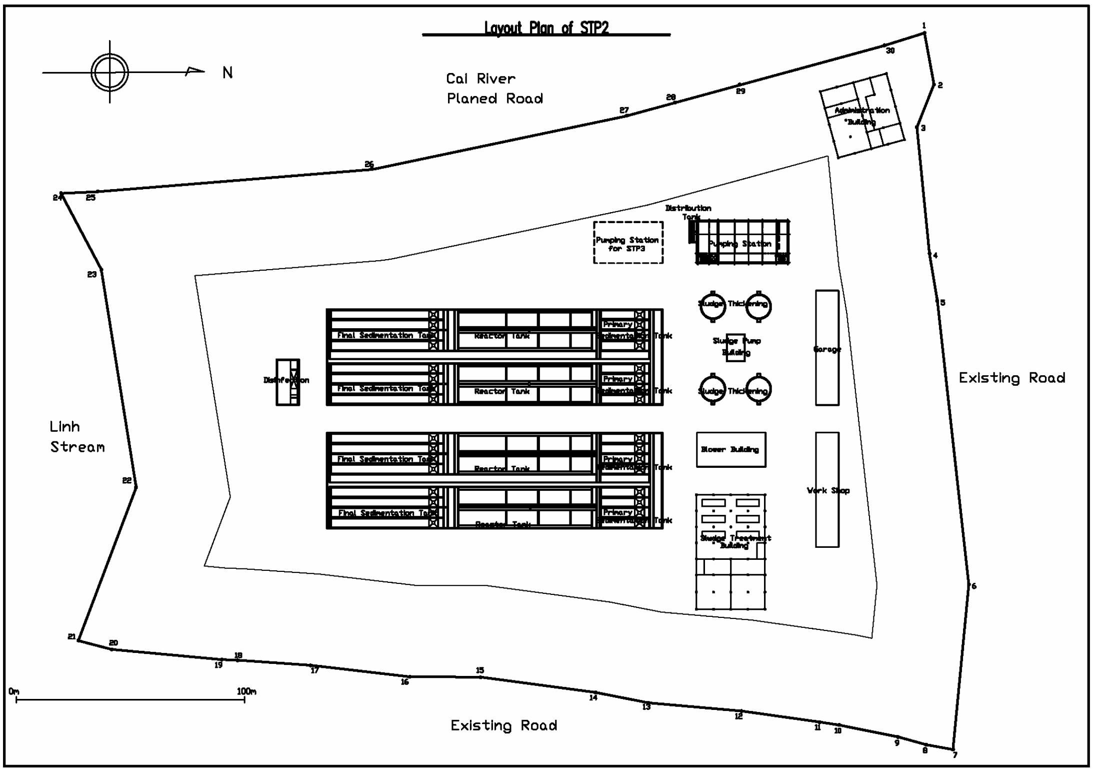


Figure 5.3.4 Layout Plan of STP2

The hydraulic profile for each unit process is presented in Figure 5.3.5. The water level is determined by the high water level of the receiving stream (Linh Stream). Hydraulic calculations are shown in Appendix 5 - E.

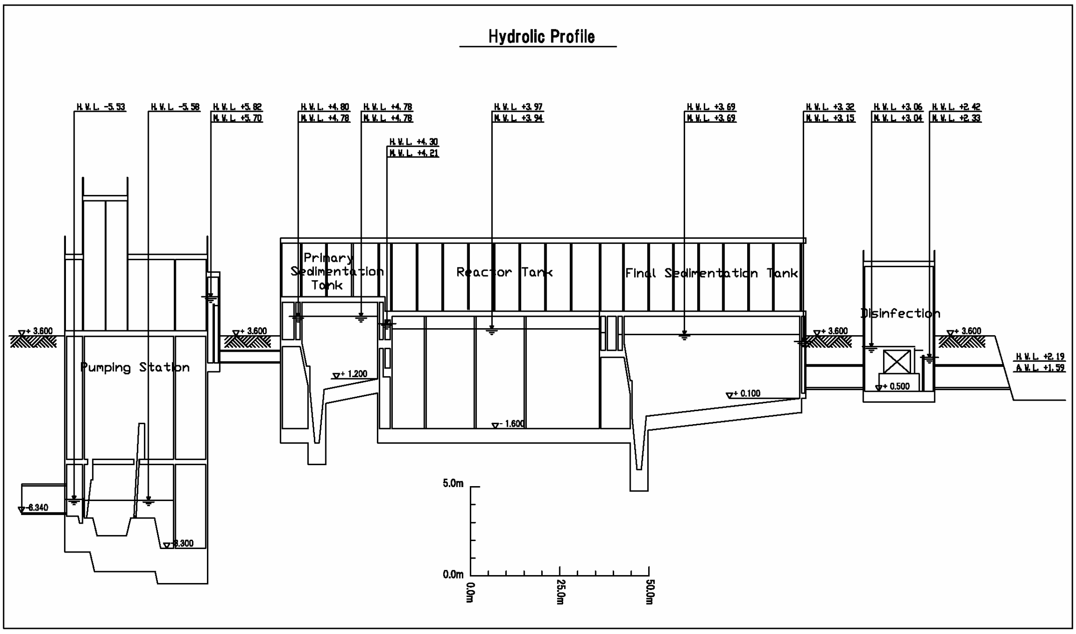


Figure 5.3.5 Hydraulic Profile of STP2

5.3.4 Sewage Sludge Disposal Site

Sludge generated at STP2 would be disposed at Trang Dai Landfill Site, which is 10 km away from STP2. The Landfill Site managed by URENCO is a sanitary landfill and has a treatment plant for leachate collected from the landfill. URENCO has indicated that it will accept sludge from STP2 in the future but has not specified the acceptable amount, organic matter contents and moisture contents.

Sludge from septic tanks will be received and treated at STP2. Septic tank waste will be mixed with sewage at the inlet from the main pumping station.

Sludge produced by the treatment process will be thickened by gravity and mechanically dewatered to more than 20% solids content. to reduce the volume and improve handling..

The sludge volume from STP2 will increase to more than 50m^3/day in future. It can be conveyed to the landfill site by dump trucks with a 10 ton capacity.

Calculation for number of trucks

- Sludge volume (in 2030) = 60m^3/day (daily maximum) /1.15 = 52.2m^3/day (daily average)
- Capacity of Truck: 10t (≒10m^3)
- Required number of trucks = 53.2m^3/day / 10m^3/truck = 5.4 trucks
- Frequency of usage: 2 times/day (including loading and unloading work, transportation of round trip, washing of loading platform.)
- Number of drivers and trucks for sludge disposal = 5.4 trucks / 2 times = 3 trucks
- Number of drivers and trucks collecting and transport for screenings and girt of STP and PS-1 = 2 trucks
- Total minimum number of trucks = 5

5.3.5 Considerations for Wet Weather Operations

STPs serving combined sewer systems can be adversely affected by storm events. Sudden peaks in flow can increase the amount of grit and screening received at the pumping station and wash out the biological solids in the secondary process. Sudden increases in flow can have an adverse affect on primary sludge blankets and pumping rates. Dilute sewage can result in lower MLSS thereby affecting the removal efficiency and quality of final effluent.

The wet weather volume at STP2 is about one third of the entire inflow in 2020. During wet weather sewage strength is diluted to three quarter of the design sewage strength. The estimated influent sewage quality at STP2 during wet weather is shown in the Table 5.3.5.

Table 5.3.5 Estimated Influent Quality of STP2 in Rain Season

Item	Unit	Dry season	Rain season in 2020	Rain season in 2030
BOD_5	mg/l	200	152	178
SS	mg/l	250	190	222
T-N	mg/l	41	31.1	36.5
T-P	mg/l	6.4	4.6	5.7

The treatment plant should be designed to increase operational flexibility during wet weather. General recommendations for design and operation include:

- controlled by-passing of some unit processes as primary sedimentation tank
- using step feed aeration to prevent washout
- reducing plant recycle rates during wet weather to minimize the impact of impaired treatment capacity on effluent quality
- reducing the dissolved oxygen and sludge retention times during wet weather to avoid sludge bulking.
- improving flow splitting to get equal distribution to each process stream to prevent hydraulic overloading

CHAPTER 6 PRELIMINARY PLAN AND DESIGN OF THE DRAINAGE SYSTEM

6.1 Design Criteria

Design criteria for drainage systems are based on the Vietnamese Standard (TCVN 7957-2008) and formulas are given by MOC.

Runoff is calculated by using the rational method

Runoff Q (l /sec) is

(F < 300ha)

- $Q = q \times C \times F$

(F >= 300ha)

- $Q = C \times q \times F \times \phi$

where; q: Rainfall intensity (l /s /ha)

C: Runoff coefficient

F: Area (ha)

ϕ : Coefficient of rainfall distribution given bellow

$$\phi = 1/(1+0.001 \times F^{(2/3)})$$

Rainfall intensity (q) is

$$q = \frac{A(1 + c \lg P)}{(t + b)^n}$$

where; coefficients of A, c, b, n are specified in appendix B of TCVN 7957-2008, The standard does not provide specific coefficients for Bien Hoa City, therefore the coefficients for Ho Chi Minh City are used because of it's close proximity.

A: 11,650

c: 0.58

P: Return period of rainfall

t: Concentration time (min), $t = t_0 + t_1 + t_2$

t_0 : Time of runoff to road side drain (min)

t_1 : Time of flow from road side drain to inlet manhole (min)

t_2 : Time of flow from inlet manhole to section in question (min)

The value of "t1 + t2" which is estimated to be 10 minutes for Bien Hoa.

$$t_2 = 0.017 \sum \frac{L_2}{v_2}$$

L_2: Length of sewer (m)

v_2: Velocity in each respective sewer (m/sec)

b: 32

n: 0.95

Typical rainfall return periods for drainage structures are given in Table 6.1.1.

Table 6.1.1 Return Period of Rainfall

Urban Size	Drainage Structure Sizes		
	Canal, Stream	Main sewer	Branch sewer
Large cities, Catagory 1	10	5	2 – 1
Catagory 2 and 3 cities	5	2	1 – 0.5
Other cities	2	1	0.5 – 0.33

Source: TCVN 7957-2008

According to decision No. 219/TTg, May 10 1993, Bien Hoa city has been classified as a category 2 city therefore the return periods for rainfall are as follows:

- Canals : 5 Years
- Drainage Main Sewers : 2 Years
- Drainage Branch Sewers : 1 Year

Run-off coefficients (C) are a function of surface type and slope as given in Table 6.1.2.

Table 6.1.2 Runoff Coefficients

Characteristic of surface	Return period of rainfalls (year)				
	2	5	10	25	50
- Asphalt road surface	0.73	0.77	0.81	0.86	0.90
- Concrete roof	0.75	0.80	0.81	0.88	0.92
-Grassplots, gardens, parks (grass takes under 50% of the area)					
- Small slope 1-2%	0.32	0.34	0.37	0.40	0.44
- Medium slope 2-7%	0.37	0.40	0.43	0.46	0.49
- Big slope	0.40	0.43	0.45	0.49	0.52

Source: TCVN 7957-2008

Runoff coefficients adopted by the study team are as follows.

- Canals : 0.77 (Asphalt - impervious)
  : 0.34 (Grassplots, gardens, parks - pervious)
- Sewers : 0.74 (Average of Asphalt road and Concrete roof)

The runoff coefficient for canals is based on the estimated proportion of pervious and impervious surface area in the contributing catchment.

6.2 Design Consideration

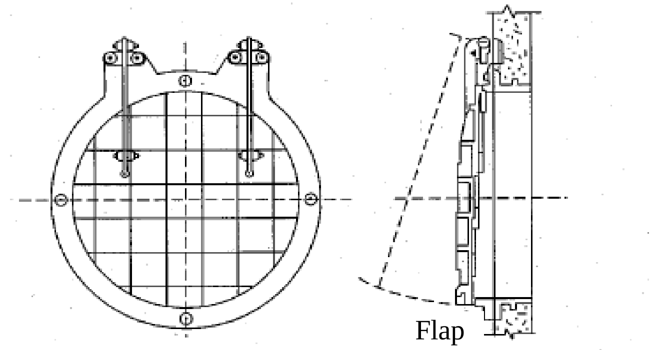
6.2.1 Effective Use of the Existing Drainage System

Existing drains are shown in Table 3.4.1 and Figure 3.4.2 of Chapter 3 of this report. The capacity of existing drains in the priority area are checked by hydraulic calculation and fully utilized as combined sewers and drains in this study.

6.2.2 Outlet Conditions

Almost all of the storm water outlets are just at or below river water level even in the dry season. Outlets on combined systems must therefore be protected with flap gates or sluice gates to prevent the inflow of river water into the interceptor.

A flap gate is a mechanical device that automatically opens and closes by flow and water pressure without motive energy. Figure 6.2.1 shows a typical flap gate at outlet and features of flap gate are shown in Table 6.2.1.



Source: Manual of combined sewer improvement measures 2002 (Japan Sewerage Works Association)

Figure 6.2.1 Flap Gate

Table 6.2.1 Features of Flap Gate

Classification	Features
Advantage	Preventing backflow automatically Easy setting No electricity
Disadvantage	Small flow or low pressure may not open or close the gate Garbage bother automatic movement (open and close) Cleaning works are required

Flap gates are required at each combined sewer overflow chamber as shown in chapter 5, figure 5.2.1.

6.3 General Layout Plans

6.3.1 Drainage Systems

The drainage system is designed for the same priority area that is served by the sewerage system. The general layout plan is shown in Figure 6.3.1. Drawings and hydraulic calculation sheets are attached in appendix 6-A and 6-B, respectively.

Drainage pipes from Bien Hung Lake to Dong Nai River are designed as siphon structures, and these are influenced by daily tidal fluctuations.. Therefore, sluice gates have to be installed.

Lengths of drainage sewer are shown in Table 6.3.1. Numbers and sizes of flap gates and sluice gate are shown in Table 6.3.2.

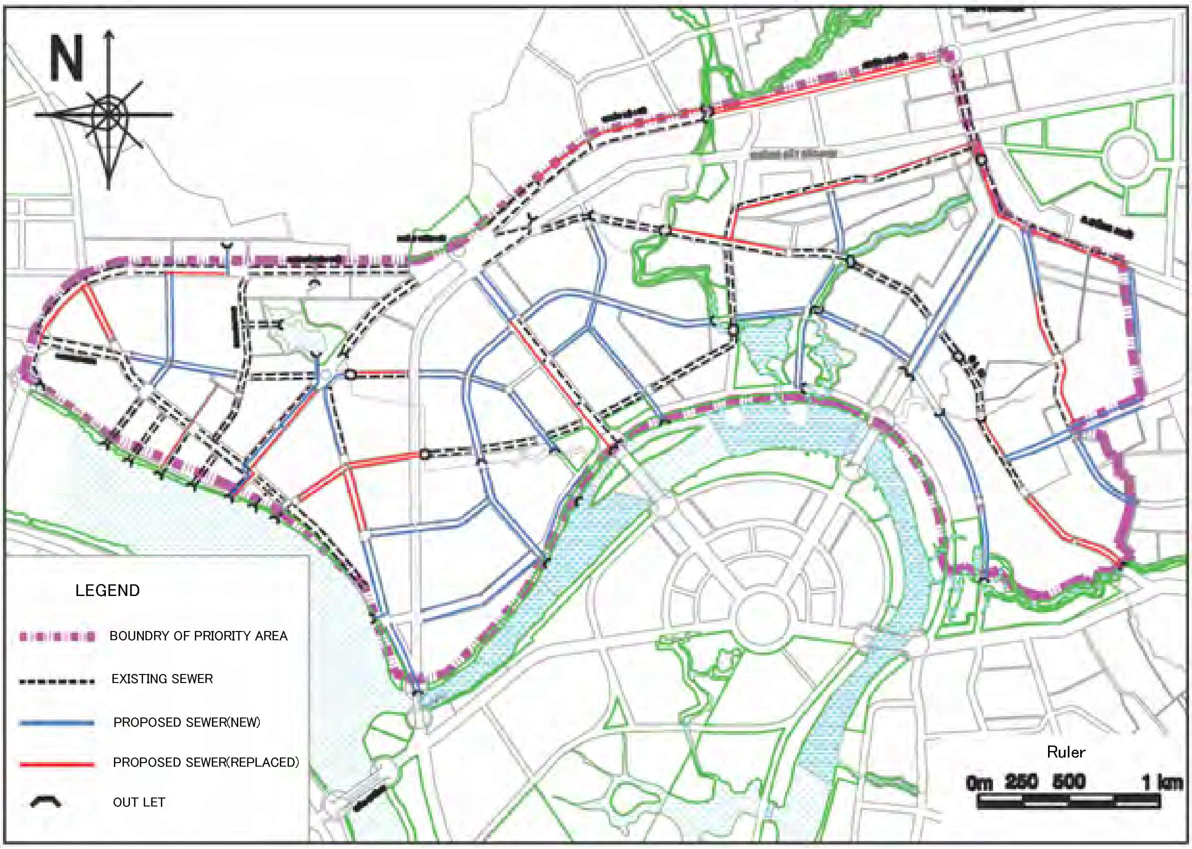


Figure 6.3.1 General Layout Plan of Drainage System

Table 6.3.1 Lengths of Drainage Sewer

Drainage Sewer		
D or B×H *1 (m)	Length (m)	Remarks
0.5	110,000	Branch Sewer
0.6	3,020	
0.8	6,590	
1.0	12,740	
1.2	9,570	
1.5	6,105	
1.8	4,025	
2.0	1,670	
2.0×2.0	1,175	
2.5×2.5	375	
3.0×3.0	105	
Total	165,670	
Combined Sewer		
0.6	655	
0.8	1,430	
1.0	2,640	
1.2	2,015	
1.5	660	
1.8	1,370	
2.0	1,025	
2.0×2.0	500	
Total	10,295	
Grand Total	213,205	

*1 D : Diameter, B : Width of Box Culvert, H : Hight of Box Culvert

Table 6.3.2 Numbers and Sizes of Flap Gate and Sluice Gate

Shape	Size (mm)	Number	Flap gate/Gate
Circle	600	5	Flap gate
	800	1	Flap gate
	1,000	3	Flap gate
	1,200	3	Flap gate
	1,500	2	Flap gate
	1,800	2	Flap gate
	2,000	1	Flap gate
	2,300	2	Sluice Gate
Rectangle	2,000×2,000	2	Flap gate
	3,000×2,500	1	Flap gate
Total		22	

6.3.2 Canals

The location of canals included in Priority Project I are shown in Figure 6.3.2. Preliminary design consist of calculating the cross section required to handle the calculated run-off. Lengths of streams and ditches are shown in Table 6.3.3. General Layout plan, hydraulic calculation sheets, and detailed drawings are attached in appendix 6-C, 6-D and 6-E, respectively.

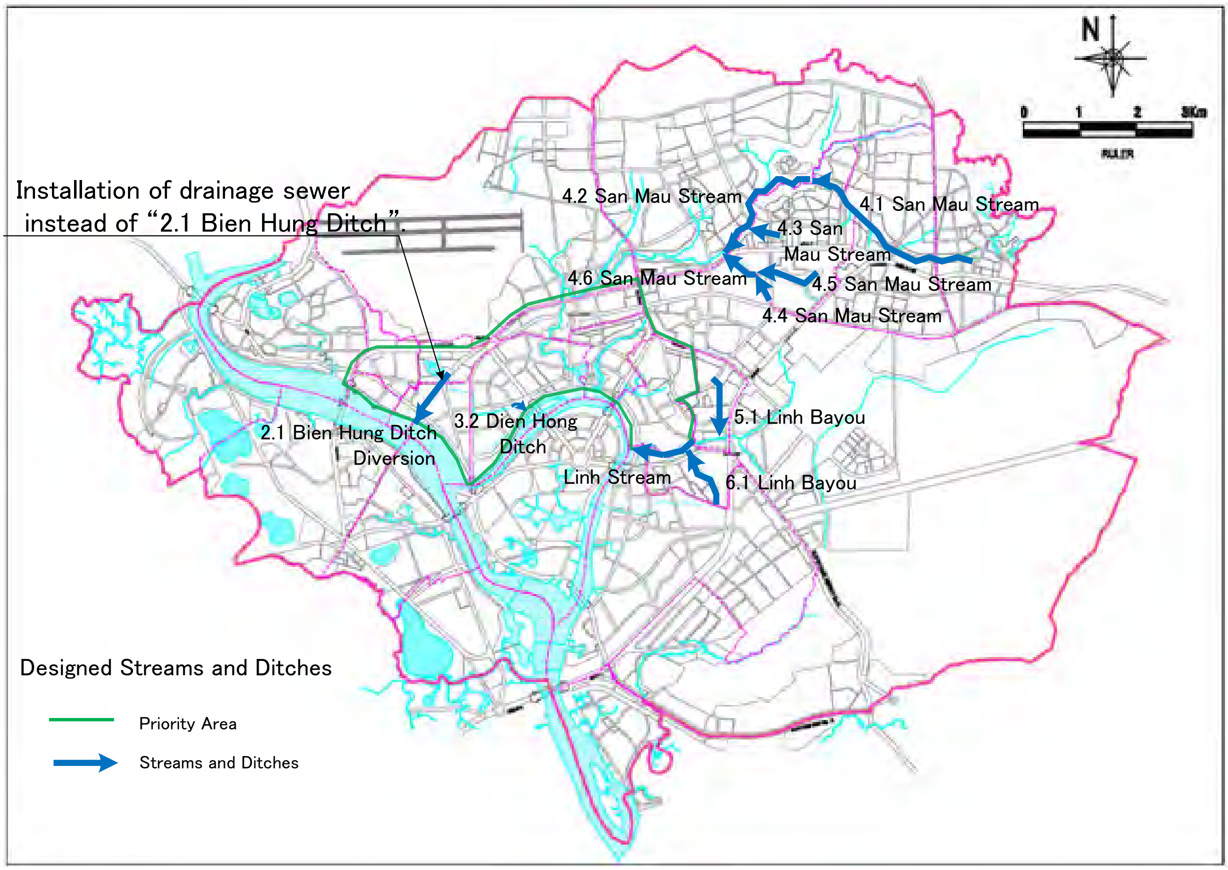


Figure 6.3.2 General Layout Plan of Canals

Table 6.3.3 Lengths of Canals

Stream/Ditch	No.	Upper width	Bottom width	Height	Inclination	Length
Name		(m)	(m)	(m)	(m/m)	(m)
2.1 Bien Hung Ditch Diversion	1	2×Diameter 2.3m (Instead of Bien Hung Ditch)				2,160
Sub-total						2,160
3.2 Dien Hong Ditch	1	30.00	20.00	1.80	1.25	374
Sub-total						374
4.1 San Mau Stream	1	3.00	1.50	1.50	0.50	314
	2	6.00	4.00	2.00	0.50	419
	3	8.50	6.00	2.50	0.50	770
	4	10.70	7.50	3.20	0.50	624
	5	10.70	7.50	3.20	0.50	852
	6	11.00	7.50	3.50	0.50	676
Sub-total						3,655
4.2 San Mau Stream	1	12.75	7.50	3.50	0.75	1,155
	2	13.50	7.50	4.00	0.75	304
	3	13.50	7.50	4.00	0.75	472
	4	13.50	7.50	4.00	0.75	553
Sub-total						2,484
4.3 San Mau Stream	1	2.90	2.00	1.80	0.25	398
Sub-total						398
4.4 San Mau Stream	1	3.50	2.50	2.00	0.25	615
Sub-total						615
4.5 San Mau Stream	1	2.75	2.00	1.50	0.25	324
	2	5.25	4.00	2.50	0.25	744
	3	5.25	4.00	2.50	0.25	247
Sub-total						1,315
4.6 San Mau Stream	1	9.75	6.00	2.50	0.75	727
Sub-total						727
5.1 Lin Bayou	1	5.00	2.00	2.00	0.75	478
	2	6.00	3.00	2.00	0.75	276
	3	6.75	3.00	2.50	0.75	223
	4	6.75	3.00	2.50	0.75	83
Sub-total						1,060
6.1 Lin Bayou	1	3.75	1.50	1.50	0.75	401
	2	3.75	1.50	1.50	0.75	205
	3	5.20	2.50	1.80	0.75	379
	4	5.20	2.50	1.80	0.75	169
Sub-total						1,154
Linh Stream	1	14.25	6.00	2.75	1.50	370
	2	16.00	7.00	3.00	1.50	407
	3	18.20	8.00	3.40	1.50	378
Sub-total						1,155
Total						15,097

A typical canal cross section is shown in Figure 6.3.3.

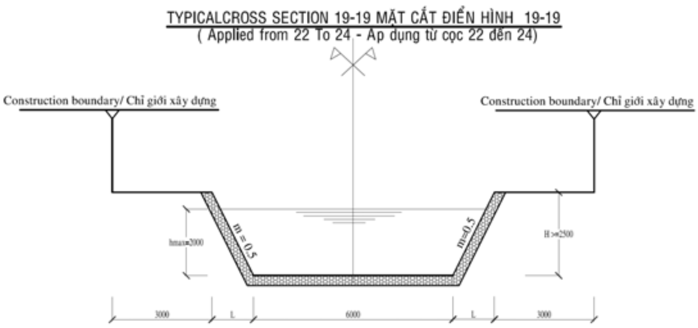


Figure 6.3.3 Typical Canal Cross Section

CHAPTER 7 INSTITUTIONAL ARRANGEMENT FOR IMPLEMENTATION

7.1 Institutional Framework for Drainage and Sewerage Management in Viet Nam

On 28 May 2007, the Prime Minister of the Government of Viet Nam issued a new Decree (88/2007/ND-CP) on "Drainage and Sewerage for Urban Areas and Industrial Zones". Decree 88 is the first attempt in Viet Nam to establish regulations on drainage/sewerage systems in urban and industrial areas in the country. It stipulates mostly already established practices: the Central Government assumes overall responsibilities for state management of drainage/sewerage systems of the country, including the issuance and guidance for implementation of policies, strategies, and orientations on drainage/sewerage development at national level. Such responsibilities are shared and undertaken by: the MOC for the overall management of drainage/sewerage systems and the development of programs/plans; MONRE for environment protection and pollution control; MARD for irrigation protection and granting/withdrawing permission of sewage discharging to irrigation works; MPI (together with MOF) for budgeting programs/plans approved by the Prime Minister and mobilizing ODA funds for those programs/plans; and MOF (together with MOC) for guiding, supervising and inspecting collection and use of sewage disposal tariffs.

At the provincial and/or city level, the People's Committees, with the assistance of provincial departments such as the Department of Construction, are responsible for the management of drainage/sewerage projects within their respective areas of jurisdiction. They assign professional agencies/entities to undertake project planning and implementation activities and to provide operation and maintenance services.

Each drainage/sewerage project is prepared either by MOC (for inter-provincial drainage/sewerage program/plan or project) or the Provincial People's Committees (for provincial or urban programs/plans, which need to be endorsed by MOC for the Prime Minister's approval). Provincial People's Committees (PPCs) do not actually prepare projects but approve the projects prepared by the Provincial Department of Construction in association with the drainage/sewerage servicing entities. PPCs regulate entities in charge of all discharge points and the quality of the area's drainage/sewerage system in accordance with the regulations set by the MONRE.

Drainage/sewerage plans should be integrated with other infrastructure development plans such as roads and irrigation works, and have to get approval from the relevant authorities. Concurrently, transport and irrigation plans need to be consulted and approved by the entities responsible for drainage/sewerage management.

The development of drainage/sewerage systems have been funded in the past and would be funded in the foreseeable future by state and local budgets. MOF, in cooperation with MPI and MOC, would examine the mechanism of the state budget allocation to the specific drainage/sewerage work for the submission to the Prime Minister, who finally approves the proposed work. However, in the past, under most of the larger scale water supply and/or drainage/sewerage projects in Viet Nam, whole investment costs were funded by the central government grant which generally comprises ODA and state/local budget.

Decree 88 does not clearly indicate percentage of the state budget allocation; it encourages the increased financing by local level for the drainage/sewerage project and self-financing in industrial and new urban areas. PPCs’ contributions are the main source of the local level’s financing. Generally such contributions are in kind, like bearing land acquisition cost. In addition to PPCs’ contributions, City People’s Committees (CPCs) would also contribute some of the required funds for the drainage/sewerage development project. Based on the percentage of the investment contribution by the CPC, it may be granted partial ownership of the project. Decree 88 also encourages community participation in monitoring of construction, operation and maintenance (O&M) of the drainage/sewerage works. To this end, community campaigns at all levels and by all institutions concerned have to be undertaken.

People’s Committees nominate organizations/entities which operate and maintain the drainage/sewerage system and provide services to the users. The cost required for O&M has to be fully borne at the local level. To meet this responsibility, Decree 88 explicitly states that tariffs should be determined correctly and sufficiently based on the principle of cost recovery. With this scheme, not only expenses for O&M but also partial contribution to the capital investment have to be built in the tariffs. Taking this cost recovery into consideration, Decree 88 stipulates that the drainage/sewerage tariffs should not be lower than 10% of water tariffs. Tariffs also have to be determined based on sewage volumes used by users and pollutant loading. Under the current regulations, all tariffs collected need to be surrendered to the People’s Committees concerned, and People’s Committee in turn transfers the necessary funds to the drainage/sewerage O&M entities.

7.2 Existing Drainage/Sewerage Services in Bien Hoa City

7.2.1 Organization of Administrative Bodies of Dong Nai Province

The following are brief descriptions of the major tasks and responsibilities of the Department of Planning and Investment (DPI), Department of Finance (DOF), Department of Natural Resources and Environment (DONRE), and Department of Construction (DOC), which are related to the water supply, sewerage and drainage services:

(1) Department of Planning and Investment (DPI)

DPI’s roles in implementation of sewerage and drainage projects are to;

- assist PPC on state management in planning and investment,
- give general advice on strategies, projects and plans for social and economic developments annually, every five years and in the long term; on policies and guidelines on domestic and

foreign investment and investment in industrial zones and export processing zones; and on the management of ODA and bidding for contracts,

- issue certificate on business registration for local enterprises in accordance with enterprises' law and state enterprises' law, and
- assist PPC in carrying out its objectives and plans that are proposed by the province.

(2) Department of Finance (DOF)

DOF's roles in implementation of sewerage and drainage projects are to;

- instruct and inspect the administrative organizations, non-productive agencies under the province, and lower level financial agencies to build up the state budget annual estimate in accordance with the regulations of the law,
- take responsibility in the appraisal of the budget estimates of the agencies, units at the same level, or lower-level PC,
- prepare estimates for collecting state budget within the province area, estimates for collecting and spending local budget, plan of allocation of the provincial budget, and report to PPC for future submission to the People's Council for their decision,
- coordinate the agencies' activities in the implementation of the collection management of taxes, fees, charges and other revenue amounts within the provincial area,
- coordinate with DPI and other concerned agencies to prepare the estimate and distribution plan for annual investments on capital construction, coordinate with concerned agencies to arrange other financial resources which have nature of capital construction annual investment, for submission to PC for approval,
- instruct employers to make a schedule on annual investment capital in accordance with the regulations of the Law on State Budget, coordinate with the DPI in submission to PPC regarding the decision on investment capital allocation, establishment of additional adjustment plan, harmonizing investment capital paid for projects invested through local budget,
- check and monitor the branch of the development assistance fund in the province, in lending, interest assistance, guarantee, re-guarantee for the investment portion from the local budget delegated by PPC to the branch of the development assistance fund for execution.

(3) Department of Natural Resources and Environment (DONRE)

DONRE's roles in implementation of sewerage and drainage projects are to;

- assist PPC in the implementation of state management of land resources, water resources, mineral resources, environment, and hydrometeorology, geodesy and maps; exploitation of mineral resources into ordinary building materials, such as earth, sand, stones, lime and so on.

(4) Department of Construction (DOC)

DOC's roles in implementation of sewerage and drainage projects are to;

- be responsible to PPC in terms of performing the function of state administrative management in the fields of construction as defined by the laws, rules and the regulations issued by the state. Such aspects include construction, building materials, dwelling houses and public offices, architecture, planning for urban construction, planning for building rural residential areas, urban infrastructure (such as urban streets, water supply, water drainage, parks and tree plantation, urban rubbish disposal, cemetery, urban vehicle stands).

7.2.2 Bien Hoa Urban Environment Service Company (URENCO Bien Hoa)

(1) Overview

The Bien Hoa Urban Environment Service Company (URENCO Bien Hoa) was converted into a one-member state owned limited liability company in April 2008. It is owned by DNPPC and operated according to state business laws for public utilities.

The major task of URENCO Bien Hoa is to deal with environmental matters, specifically to collect and treat wastes in urban areas and industrial parks in Dong Nai province. To ensure environmental hygiene, the company works actively in cleaning the roads and streets as well as in collecting, transporting and treating garbage. In 2009, URENCO Bien Hoa collected and treated 179,000 tones of garbage and started getting involved in treating solid wastes and dangerous wastes from medical facilities. In addition to solid waste management the company also manages the public lighting and the traffic light system, maintains roads and bridges, manages public parks and trees, and cleans drains and sewers.

URENCO Bien Hoa is expediting some large-scale investment projects to improve its waste treatment capability. One of these projects is to build underground dumping sites totaling 15ha in Trang Dai ward of Bien Hoa City. Total investment in this project is VND30 billion. The project consists of two stages. In the first stage, eight underground dumping sites have been built. In the second stage, construction of an additional four underground dumping sites is underway.

URENCO Bien Hoa is coordinating with Vinh Cuu district to complete the site clearance-related work to build the 50ha Vinh Tan dumping site. The company is also asking for permission to build a facility to burn medical wastes in the area of the Trang Dai dumping site. This facility would have the capacity to burn five tons of medical wastes per day. Total investment in this project is VND17 billion.

With the above mentioned investment projects, URENCO Bien Hoa would continue to make great contributions to protecting the environment in Dong Nai province in the industrialization and modernization process.

(2) Organization and Resources

The company uses a matrix organizational structure to effectively combine function and service delivery. As shown in Table 7.2.1 the company is divided into 9 environmental services sections that carry out the work. The environmental service team is supported by 4 management departments and 1 technical department. There are currently are 707 employees including 82 people that are employed on a contract basis for collection of solid waste. Only 11 employees have engineering or environmental science degrees.

Table 7.2.1 URENCO Organizational Structure and Staffing Levels

Management/Departments		Staff No.	Responsibilities
Director		1	Central Executive Officer
Vice Directors		2	
Management Departments	General controlling	1	
	Administration and Human Resource	20	
	Business	10	
	Finance/Accounting	8	
	Technical	10	
	(sub-total)	(49)	
Environment Service Team	Environmental Enterprise of Bien Hoa	304	Collection/Cleaning of solid wastes in the Bien Hoa City including solid waste from hospitals; transportation of solid wastes and sludge to disposal sites; management of landfill site
	Cemeteries Management Centre	33	Maintenance of cemeteries
	Park management I	77	Maintenance of parks
	Park management II	63	Maintenance of parks
	Trees and ornamental plant	56	Cultivate seedlings and ornamental plant for public sites
	Transportation works	73	Maintenance of drains/sewers, side-walks, and sign boards
	Mechanical maintenance	11	Repairing vehicles and equipment
	Road Lighting System	20	Maintenance of road lighting system
	PMU of Bien Hung night-market	18	Operation and maintenance of night-market
	(sub-total)	(655)	
Total		707	

Source: URENCO Bien Hoa

Table 7.2.2 URENCO Maintenance Achievements in Cleaning Sewers and Drains

Maintenance	Unit	2006	2007	2008	2009	2010
sewers	m	27,634	38,121	40,044	62,512	65,712
drains	m	35,630	36,509	37,890	48,523	49,205

JICA Study Team notes that the length of sewers and drains increased by more than 50% in 2009 adding significantly to the workload. This increase in length is an indication of the rapid pace of urbanization in Bien Hoa City.

The sewer/drain maintenance function is poorly equipped and uses only simple tools for removing debris and sludge from sewers and drains. They have bucket machines that they use for sewer cleaning but no high pressure jetting or vacuum suction vehicles.

All sewers and drains are cleaned once a year according to a planned schedule. Sewers are frequently inspected but there is no indication that some sections require more maintenance than others. URENCO reports that the biggest maintenance problem is damage to concrete storm water drains by heavy vehicles (broken covers and broken sidewalls).

7.3 Public Private Partnerships

7.3.1 Models of Public Private Partnerships

Public-Private Partnership (PPP) refers to a public entity entering into a contractual agreement with a private sector party which takes over some or all of its activities to provide services for the general public. PPP models vary from short-term simple management contracts (with or without investment requirements) to complex long-term BOT arrangements and divestitures. PPP for infrastructure projects usually fall into the following four broad categories:

- management and lease contracts
- concessions (or management and operation contracts with major private capital expenditure)
- greenfield projects
- divestitures

Acronyms Used in the Private Participation in Infrastructure Projects

- BLT Build, Lease, Transfer
- BOT Build, Operate, Transfer
- BOO Build, Operate, Own
- BROT Build, Rehabilitate, Operate, Transfer
- BTO Build, Transfer, Operate
- RLT Rehabilitate, Lease, Transfer
- ROT Rehabilitate, Operate, Transfer

(1) Management and Lease Contracts

A private entity takes over the management of a state-owned enterprise for a fixed period while ownership and investment decisions remain with the state. There are three subclasses of management and lease contracts:

- management contract - The government pays a private operator to manage the facility. The operational risk remains with the government.
- lease contract - The government leases the assets to a private operator for a fee. The private operator takes on the operational risk and retains the revenue.
- Affermage lease - the operator and contracting authority share revenue from customers. The operator pays the contracting authority an affermage fee, which varies according to demand and customer tariffs, and retains the remaining revenue.

With leases the operator's profits depend on the utility's sales and costs, which typically give the operator incentive to improve operating efficiency and increase sales. This type of arrangement is often used for the commercialization of water utilities.

Under a lease, the operator's remuneration depends directly on the customer tariff, so the government is obliged to design an arrangement that protects the operator from tariff-related policy risks.

(2) Concessions

i) Existing Infrastructure

A private entity takes over the management of a state-owned enterprise for a given period during which it also assumes significant investment risk. Concessions can be classified according to the following categories:

- Rehabilitate, operate, and transfer (ROT): A private sponsor rehabilitates an existing facility, then operates and maintains the facility at its own risk for the contract period.
- Rehabilitate, lease or rent, and transfer (RLT): A private sponsor rehabilitates an existing facility at its own risk, leases or rents the facility from the government owner, then operates and maintains the facility at its own risk for the contract period.
- Build, rehabilitate, operate, and transfer (BROT): A private sponsor builds an add-on to an existing facility or completes a partially built facility and rehabilitates existing assets, then operates and maintains the facility at its own risk for the contract period. BROT is a popular form of PPP in the water supply sector.

In concessions, payments can go both ways: concessionaire pays to government for the concession rights and the government may also pay the concessionaire under certain specific conditions. Sometimes payments by government are required to improve the commercial viability of the projects and/or reduce the level of commercial risk taken by the private sector, particularly in the initial years of a PPP in a country when the private sector may not have enough confidence or experience in undertaking such a commercial venture.

ii) Greenfield Projects

Greenfield refers to projects where there is no constraint imposed by prior works i.e. there are no existing facilities. The analogy is to that of construction on greenfield land where there is no need to remodel or demolish an existing structure.

A private entity or a public-private joint venture builds and operates a new facility for the period specified in the contract. The facility may return to the public sector at the end of the concession period. Greenfield projects can have the following arrangements:

- Build, lease, and transfer (BLT): A private sponsor builds a new facility largely at its own risk, transfers ownership to the government, leases the facility from the government and operates it at its own risk up to the expiry of the lease. The government usually provides revenue guarantees through long-term take-or-pay contracts for bulk supply facilities or minimum traffic revenue guarantees.

- Build, operate, and transfer (BOT): A private sponsor builds and operates a new facility at its own risk, and then transfers the facility to the government at the end of the contract period. The private sponsor may or may not have the ownership of the assets during the contract period. The government usually provides revenue guarantees through long-term take-or-pay contracts for bulk supply facilities or minimum traffic revenue guarantees.
- Build, own, and operate (BOO): A private sponsor builds and operates a new facility at its own risk, while retaining ownership of the facility at its own risk. The government usually provides revenue guarantees through long-term take-or-pay contracts for bulk supply facilities or minimum traffic revenue guarantees.
- Merchant: A private sponsor builds a new facility in a liberalized market in which the government provides no revenue guarantees. The private developer assumes construction, operating, and market risk for the project (for example, a merchant power plant).

In a BOT concession, often the concessionaire may be required to establish a special purpose company (SPC) for implementing and operating the project. The SPC may be formed as a joint venture company with equity participation from multiple private sector parties and the public sector. In addition to equity participation, the government may also provide capital grants or other financial incentives to a BOT project. BOT is a common form of PPP in all sectors in Asian countries. A large number of BOT port and road projects have been implemented in the region.

Table 7.3.1 Models of Public Private Partnerships

Type of arrangement	**Ownership of operating assets**	**Operation and maintenance**	**Capital Investment**	**Commercial Risk**	**Duration**	**Selected risks typically borne by the operator and** ****typical share of total project risk**
Management contract	Public	Private	Public	Public	3-5 years	Depends on the nature of the performance bonus ** very small
Affermage	Private	Private	Public	Shared	8-15 years	Operating and commercial risks **significant [a]
Lease -BLT -BLOT	Private	Private	Public	Private	8-15 years	Operating and commercial risks **significant
Concession -BOT -BROT -BTO	Public	Private	Private	Private	20-30 years	Operating, commercial, and investment-related risks **major.
Greenfield -BOO -BOOT	Private	Private	Private Public-Private JV	Private Shared	25-30 years	Operating, commercial, and investment-related risks **major.
Divestiture	Private	Private	Private	Private	indefinite	Operating, commercial, and investment-related risks **major

Note: The use of terms such as “affermage,” “lease,” “concession,” and “divestiture” varies, and arrangements that go by these names do not always have the features set out in the table.

a Other things being equal, the operator bears more demand risk in an affermage because the government’s payment is fixed in a lease, and variable in an affermage.

(3) Divestitures

A private entity buys an equity stake in a state-owned enterprise through an asset sale, public offering, or mass privatization program. Divestitures can be classified in two categories:

- Full: The government transfers 100% of the equity in the state-owned company to private entities (operator, institutional investors, and the like).
- Partial: The government transfers part of the equity in the state-owned company to private entities (operator, institutional investors, and the like). The private stake may or may not imply private management of the facility.

7.3.2 PPP Projects in the Water Sector

The World Bank maintains a database on infrastructure projects with private sector participation in 137 low- and middle-income countries i.e. developing countries. The database currently has information on more than 4,600 infrastructure projects dating from 1984 to 2009. To gain some insight into the types of PPP arrangements that might be considered for this sewerage project JICA Study Team has reviewed the part of the database of PPP projects that have been implemented in the water sector since 1990. JICA Study Team looked at projects implemented worldwide and in the East Asia – Pacific Region to determine if there are any outstanding trends.

Table 7.3.2 Worldwide (1990-2009): Number of Projects in the Water Sector by Type

Project type	BROT	RLT	ROT	BOT	BOO	Lease	Mgmt	Divest	Total
Potable water treatment	12	0	38	68	10	1	3	4	136
Water utility without sewerage	15	1	23	3	0	8	13	7	70
Water utility with sewerage	83	4	49	1	1	41	35	19	233
Potable water and sewerage treatment	2	0	3	4	2	0	0	1	12
Sewerage collection	0	0	0	2	0	0	0	0	2
Sewerage treatment	6	0	35	194	7	4	5	1	252
Sewerage collection and treatment	5	0	2	2	0	0	1	0	10
Total	123	5	150	274	20	54	57	32	715

Source: World Bank and PPIAF, PPI Project Database. (http://ppi.worldbank.org) Date: 12/11/2010

Table 7.3.3 East Asia-pacific Region (1990 - 2009) Number of Projects in the Water Sector by Type

Project type	BROT	RLT	ROT	BOT	BOO	Lease	Mgmt	Divest	Total
Potable water treatment	10	0	37	44	7	1	1	4	104
Water utility without sewerage	9	0	20	2	0	3	2	6	42
Water utility with sewerage	6	0	7	0	1	0	0	0	14
Potable water and sewerage treatment	1	0	3	4	2	0	0	1	11
Sewerage collection	0	0	0	1	0	0	0	0	1
Sewerage treatment	5	0	35	163(1)	1	3	4	1	212
Sewerage collection and treatment	1	0	0	2	0	0	0	0	3
Total	32	0	102	216	11	7	7	12	387

Source: World Bank and PPIAF, PPI Project Database. (http://ppi.worldbank.org) Date: 12/11/2010

Note (1): 162 new sewage treatment plants implemented as BOT in China

Table 7.3.4 East Asia-pacific Region (1990 - 2009) Number of Projects in the Water Sector by Country

Project type	China	Indonesia	Malaysia	Papua NG	Philippines	Thailand	Viet Nam	Total
Potable water treatment plant	82	5	9	1	0	4	3	104
Water utility without sewerage	23	5	5	0	1	8	0	42
Water utility with sewerage	7	0	0	0	5	2	0	14
Potable water and sewerage treatment plant	9	0	1	0	0	1	0	11
Sewerage collection	1	0	0	0	0	0	0	1
Sewerage treatment plant	211	0	0	0	0	1	0	212
Sewerage collection and treatment	2	0	1	0	0	0	0	3
Total	335	10	16	1	6	16	3	387

Source: World Bank and PPIAF, PPI Project Database. (http://ppi.worldbank.org) Date: 12/11/2010

Most PPP contracts in the water sector are associated with domestic water supply and much less with sewerage.

JICA Study Team notes the following with regards to sewerage:

- Over 86% of the PPP projects were in China.
- Only one project involved sewage collection

- BOT is the most common model for sewage treatment plant projects, followed by ROT. Only a few have used the BOO model.
- Private sector participation in the operation of water utilities with sewerage is uncommon in the Region compared to other parts of the world. Most of this activity is concentrated in China and the Philippines and usually involves the rehabilitation and expansion of existing sewerage infrastructure under the management of a commercially viable water utility.

In 2009 investment commitments and the number of new projects declined in East Asia and Pacific (Source: World Bank PPI data update note 29 December 2009).

New energy projects and existing telecommunications operators accounted for most the annual investment. The number of projects reaching financial or contractual closure fell by 38% in 2008 compared with 2007. Most of the decline occurred in China. Excluded China, the number of projects reaching closure in the region has dropped by only14%.

One regional trend worth noting is the small size of infrastructure projects with private sector participation. While the median size of new projects in all developing countries grew from US$24 million in 2002 to US$97 million in 2008, the median size in East Asia and Pacific ranged between US$15 million and US$32 million in that period.

In water and sewerage, only China and Malaysia had new projects. In China 46 projects reached financial closure, with an investment of US$974 million. Of these, 44 are for treatment plants (40 sewage and 4 water treatment plants). The other 2 are for water utilities. In Malaysia a 27-year concession contract was signed for the Sungai Sireh potable water treatment plant.

7.3.3 PPP Projects in Viet Nam

The number of PPP projects implemented in Viet Nam is quite small and can be explained by the lack of a legal framework and regulations to support investors. Not surprisingly most of the activity has been in the energy and transportation sectors where revenues can be guaranteed.

Table 7.3.5 Total Number of PPP Projects in Viet Nam by Type and Sector

Sector	Concession	Divesture	Greenfield	Management /lease	Total
Energy	1	7	9	0	17
Telecom	1	0	3	0	4
Transport	0	0	8	0	8
Water Supply	0	0	3	0	3
Sewerage	0	0	0	1	1
Total	2	7	23	1	33

Source: World Bank and PPIAF, PPI Project Database. (http://ppi.worldbank.org) Date: 12/11/2010

Table 7.3.6 Total Investment in PPP Projects in Viet Nam by Type and Sector (US$ million)

Sector	Concession	Divesture	Greenfield	Management /lease	Total
Energy	205	340	2,467	0	3,012
Telecom	456	0	1,824	0	2,280
Transport	0	0	1,080	0	1,080
Water Supply	0	0	305	0	305
Sewerage	0	0	0	2	2
Total	661	340	5,676	2	6,679

Source: World Bank and PPIAF, PPI Project Database. (http://ppi.worldbank.org) Date: 12/11/2010

There are only 3 greenfield projects registered in the PPI database for the water sector and these are all for potable water treatment plants.

Table 7.3.7 Total Investment in PPI Projects in Viet Nam Water Sector

Project Name	Type	Arrangement	Ownership	Country	Year of financial closure	Concession period	Status
Binh An Water Corp. HCMC	Potable water treatment plant	BOT	100% private	90% Malaysian owned	1998	20 years	Operational
Thu Duc Water Project HCMC	Potable water treatment plant	BOT	100% private	90% French owned	2001	25 years	Cancelled 2003
Thu Duc Water Project (second Contract) HCMC	Potable water treatment plant	BOO	100% private	60% Vietnamese	2005	unknown	unknown

Source: World Bank and PPIAF, PPI Project Database. (http://ppi.worldbank.org) Date: 12/11/2010

7.3.4 Current Status of PPP Legislation in Viet Nam

Viet Nam has BOT regulations (former Decree 78 and the current Decree 108), pursuant to which private investors can build infrastructure under certain favorable conditions and charge a tariff agreed with the State for the use of that infrastructure for an agreed period of time. Only two BOT projects have been financed in the international markets since the BOT regulations were put in the books in 1993. BOT regulations are being amended again, but the main changes appear to be administrative not substantive.

On 9 November 2010 Vietnam's Prime Minister issued the much anticipated legal framework for Public-Private Partnership (PPP) in Viet Nam. Promulgated as Decision No. 71/2010QD-TTg (Regulation on pilot investment using Public-Private Partnership model), this "PPP Framework" would take effect on 15 January 2011 and is expected promote the development of PPP projects in Viet Nam for the next three to five years.

The PPP Framework covers pilot projects, meaning that this legislation is itself a pilot, which explains why the law is somewhat truncated when compared to other draft frameworks proposed to the MPI in the past two years.

A pilot project may be deployed in any one of the following areas: roads, bridges, tunnels, ferry, railways, railway bridges, railway tunnels, urban transport, airports, seaports, river ports, fresh water supply system, power plants and other infrastructure development and public services supply projects as decided by the Prime Minister.

To be selected as a pilot project under the PPP Framework, the project must satisfy one of the following criteria:

- The project is of great significance, large scale and/or is of urgent demand in terms of economic development as stipulated under the previous Decision No. 412/QD-TTg dated 11 April 2007 of the Prime Minister (Decision 412);
- The project is capable of returning investment capital to the investor from reasonable revenue collected from consumers;
- The project is capable of taking advantage of the private sector's technology, management and operations experience and effective use of financial capacity; or
- The project meets other criteria as decided by the Prime Minister.

Decision 412 names the following projects as priorities for development:

- Expressways: Dau Giay - Phan Thiet, Cau Gie - Ninh Binh; Ninh Binh - Thanh Hoa, etc.
- Seaports: Lach Huyen in Hai Phong, Van Phong
- International transshipment container terminal in Khanh Hoa etc.
- Airports: T2 Noi Bai in Hanoi, Da Nang international, Long Thanh international airport in Dong Nai.
- Bridges: Vam Cong, Cao Lanh
- Railways: Lao Cai - Hanoi - Hai Phong; Dong Dang - Hanoi; Yen Vien - Lao Cai, and etc

A 14.3 trillion-VND highway linking Dau Giay with Phan Thiet city is expected to be the first PPP project to be implemented under the pilot PPP framework. In July 2010, the government allowed domestic private firm Bitexco Group and IFC, World Bank Group’s financial arm, to be the first and the second investors in the Dau Giay-Phan Thiet expressway in PPP form. The third investor would be selected through an international competitive bidding early 2011.

The PPP Framework is a welcome piece of legislation that has been eagerly anticipated by international investors with an interest in Vietnam's various infrastructure sectors. While it is a positive step forward, the PPP Framework still lacks regulations and will require real life testing through implementation.

7.3.5 Potential Role of PPP in Bien Hoa

The lack of experienced and qualified personnel on a national basis in the sewerage sector is a serious constraint to the operation and maintenance of the sewerage systems. Finding suitable management candidates with operational experience and technical personnel with the required skills is always a problem. Technical assistance and capacity building projects would be required to develop the requisite skills but it would take substantial time and effort, as well as a committed donor.

In the short term (first 5 years) it may be necessary and more expedient to enter into a management contract with a specialist contractor or engineering consultant for operation and maintenance of the new sewerage system. The contract would include training and capacity building of personnel who would eventually take over responsibility for the facilities at the end of the contract.

PPP using the BOT or BOO model is unlikely for the Bien Hoa sewerage project unless private capital can be recovered through fees. Significant tariff increases would be required to make sewerage projects fully cost recoverable and such increases are unlikely to happen in the foreseeable future. The financing gap would have to be covered by the state or development banks.

Involving the private sector in the management of operation and maintenance appears to be the most promising and sensible form of PPP. Management contracts for major facilities are useful when local manpower or expertise capable of running the facility is limited. A management contract could serve as a transitional arrangement, while the public authority receives on-the job training and develops the expertise required to take over the operation.

Usually, the contract period is short, from two to five years. But a longer period may be used for large and complex operational facilities.

In June of 2009 the Urban Drainage Company (UDC) of Ho Chi Minh City signed a $2 million contract with Camp Dresser Mackee to act as the company’s operations and maintenance (O&M) manager. Camp Dresser Mackee would supervise UDC's O&M services for the 200,000 - cubic-meter-per-day (m^3/d) Dong Dieu intermediate sewage pumping station and the 141,000 - m^3/d Binh Hung STP, as well as their associated facilities.

The 12-month contract involves the management of all daily facility operations and the development of short- and long-term facility operation plans. Camp Dresser Mackee would also develop workforce and management structures, ensure the proper implementation of all UDC policies and decisions, and represent UDC in dealings with appropriate entities.

The project includes an asset condition assessment of the sewage treatment facilities and an evaluation of UDC staff and equipment, a technical review of all O&M activities, and a formal

O&M management training program. This contract is the first of its kind in Viet Nam and could serve as an example for the Bien Hoa project.

7.4 Institutional Arrangement for Project Implementation

Loan negotiations between the MOF and JICA would be carried out after the Preparatory Study has been completed and endorsed by the MOC. Prior to the loan negotiations, the MPI and the MOF would determine the financing mechanism for the Project. The construction costs for the Priority Project I would be fully born by the central government. The proceeds of the state budget would be disbursed to the Project through PPC (Provincial Treasurer).

Project Management Unit

The Dong Nai Drainage Project Management Unit (PMU) was established under the Department of Construction pursuant to PPC Decision (2677/QD.CT. UBT) issued on 30 June 2004. The PMU performs the following functions:

- Acts on behalf of the owner (PPC) for preparation, implementation and construction of investment projects including bringing the projects into operation.
- Organizes and implements consultancies in the field of drainage (including sewage collection and treatment)
- Manages and executes projects according to the requirements defined in the agreement with investors/donors

(1) Projects managed by the PMU

The PMU is currently responsible managing 8 planning projects:

i. Dau Giay wastewater drainage and treatment master plan
ii. Long Giao Town – Cam My wastewater drainage and treatment master plan
iii. Nhon Trach wastewater drainage and treatment master plan to 2020
iv. Long Thanh wastewater drainage and treatment master plan to 2020
v. Long Khanh wastewater drainage and treatment master plan to 2020
vi. Tan Phu Town wastewater drainage and treatment master plan

The PMU is also managing a large number of investment (capital works) projects that are at various implementation stages. These are identified in Table 7.4.1.

Table 7.4.1 PMU Planning and Investment Project Funding

No	Project	Amount (000' VND)	Implementation status
Planning projects			
1	Master plan of wastewater drainage and treatment in Dau Giay	263,751	In-progress
2	Master plan of wastewater drainage and treatment in Long Giao town – Cam My	168,000	In-progress
Investment projects			
1	Wastewater drainage road 25C in Nhon Trach district	74,600,000	Construction completed
2	Wastewater drainage in the West of the construction land area for Dong Nai's general hospital	5,400,000	Construction started
3	Wastewater drainage system in the central of Thanh Phu commune – Vinh Cuu district	250,000	Construction pending contract approval
4	Wastewater drainage system from Can stream bridge to Cai Sinh channel	93,061	Construction pending contract approval
5	Wastewater drainage system from industrial zone in Nhon Trach I to Ba Ky channel	126,061	Construction pending contract approval
6	Green tree wastewater drainage in Nhon Trach district	560,841	Detailed design and cost estimate complete
7	Construction of PMU Office	429,838	Detailed design and cost estimate complete
8	Wastewater drainage in Nuoc Trong Stream area, Long Than	1,206,603	Detailed design complete. Tender documents being prepared for approval
9	Wastewater drainage of Tan Phu industrial zone and Tan Phu town	7,056,905	Detailed design complete. Tender documents being prepared for approval
10	Wastewater drainage in road no. 2 (city center – road no. 19)	192,000	Detailed design complete. Tender documents being prepared for approval
11	Flood protection/relief: in Chua, Ba Lua and Cau Quan streams	1,800,000	Preparing surveys and documents for implementation
12	Wastewater treatment plan phase 1, capacity of 16,000m3/day night	100,000	Preparing for investment
13	Wastewater collector phase 1	300,000	Preparing for investment
14	Wastewater drainage from street No. 4 to Da stream, Trang Bom district.	100,000	Preparing for investment
15	Wastewater drainage and treatment in Bien Hoa city	500,000	Preparing for ODA loan
	Total	93,147,060	

Source : PMU Report – Summary of works/activities in 2009 and tasks for 2010, January 2010

It is clear from the list of projects that the PMU has been assigned a significantly large number of projects. Furthermore the nature of the projects and the level of funding indicate that Dong Nai PPC is making wastewater drainage and treatment a priority.

(2) Organization and Staffing

The PMU currently has 40 staff including the director and deputy director. Personnel costs amounted to VND 1,202 million in 2009 ($57,250).

The PMU is organized as show in Figure 7.4.1.

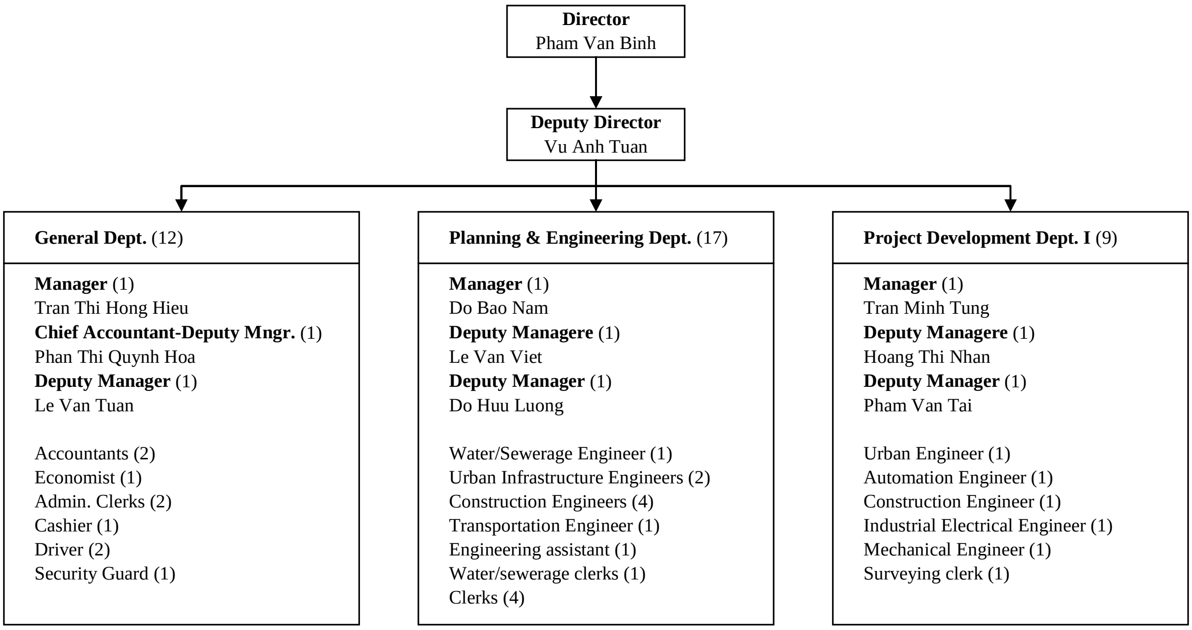


Figure 7.4.1 Existing PMU Organization Structure and Staffing Levels

Table 7.4.2 identifies engineering personnel that have received some form of training in sewage management either by university degree or continuing education after graduating.

Table 7.4.2 PMU Technical Personnel

Engineering Degree	Number of personnel	Years of experience
Water/Sewage engineers	3	2 to 3
Environmental engineers	1	7
Chemical engineers	1	5
Construction engineers	7	2 to 27

Staffing levels are more than adequate to support the project however these resources are also involved in managing many other projects. Practical experience and technical expertise in the field of sewerage management is relatively limited. Only 3 persons have university level degrees in water and sewerage engineering and these are recent graduates with only 2-3 years of work experience. JICA Study Team recommends that at least 4 of the engineers be dedicated to the project full-time during the detailed design stage.

JICA Study Team recommends that capacity building begin at the detailed design stage to ensure that all key personnel would be better prepared to make the transition to operation and maintenance of the system. Capacity building would best be delivered in the form of on the job training by including the PMU in design activities like developing base maps, using software programs for calculating sewage flows and preparing collection network drawings.

(3) Proposed Department for House Connection Administration

JICA Study Team proposes that a new department should be created within the PMU to manage the Information Education and Communication (IEC) campaign and administer house connections during the project construction stage. These two functions are described in section 8.3 of this report that discusses the house connection program. A purpose designed building should be constructed or rented to facilitate the public interaction foreseen with this department. The building should be equipped with a networked computer system installed with custom-designed database software, required for the efficient administration of the house connection program and setting up the data base for the collected information. Most importantly, the staff of the House Connection Administration Department would receive extensive job-specific training in the areas of public relations, customer service, and the use of the specialized computer software. They would also become knowledgeable with how to construct the household connection.

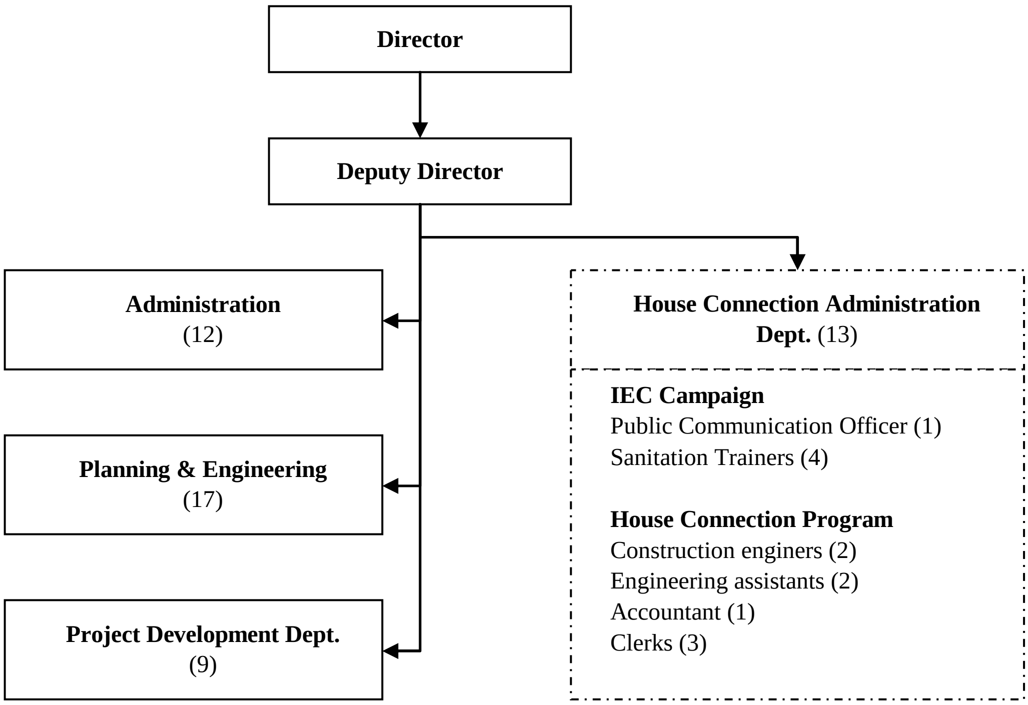


Figure 7.4.2 Proposed PMU House Connection Administration Department

All PMU staff would work closely with the Consultants (international and domestic) who would be stationed at the PMU Office for the duration of the project.

After project implementation the PMU would become part of the new Sewerage and Drainage Company to manage the new system and carry on with other sewerage development projects that would follow the first phase. The House Connection Administration Department would become part of the customer care unit to handle on-going public relations and promotion activities.

Figure 7.4.3 shows the arrangement for the project implementation, which indicates the flows of funds, guidance, and reporting responsibilities.

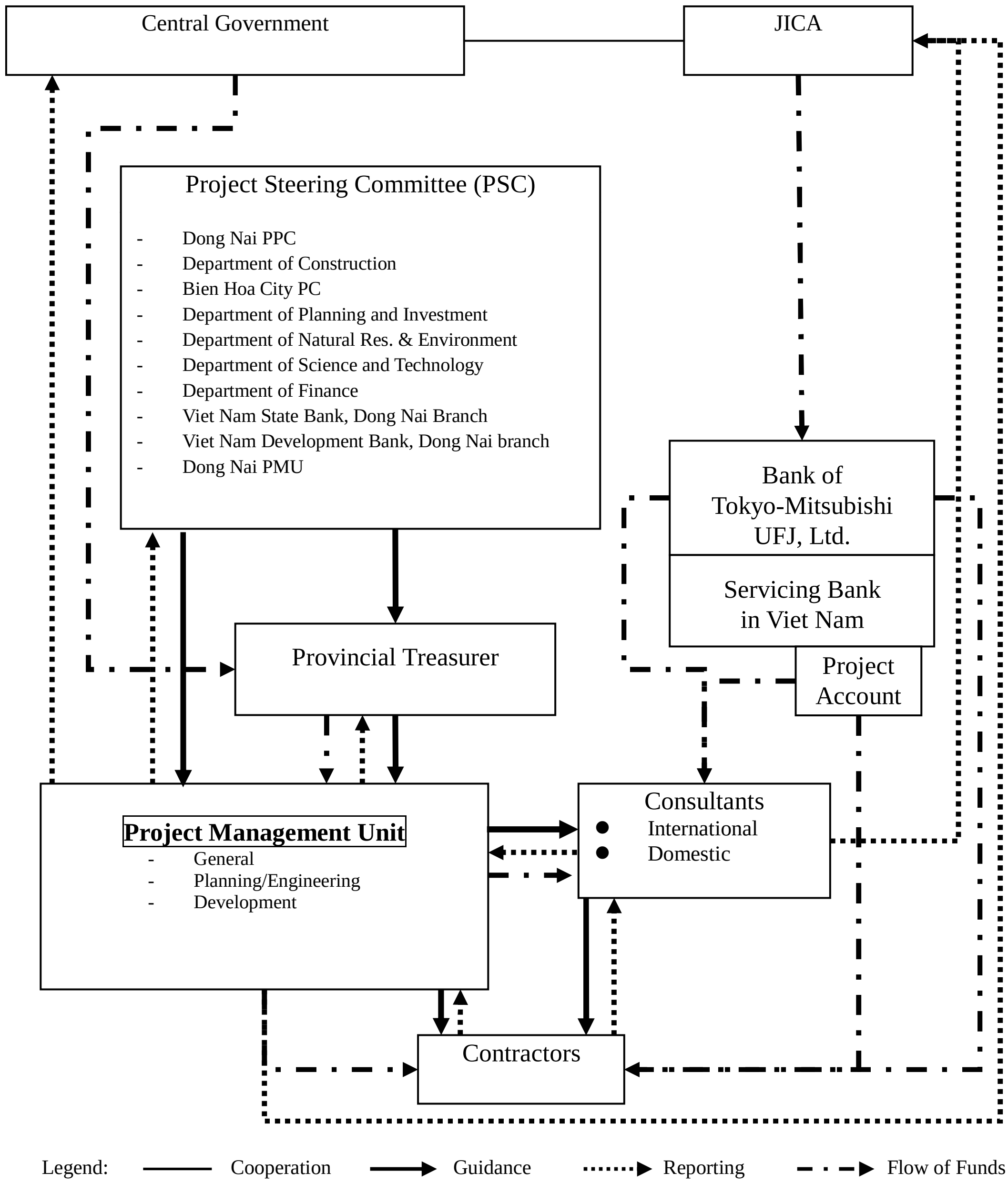


Figure 7.4.3 Project Implementation Arrangements

7.5 Organization for Operation and Maintenance

7.5.1 Selection of the Operations and Maintenance Entity

The PMU will be implementing the construction of a substantial number of sewerage and drainage projects in Bien Hoa City and Dong Nai province. These projects would create a large inventory of new infrastructure that must be operated efficiently to achieve intended environmental and health benefits. Since these projects represent significant capital investment, proper operation and maintenance is essential to protect and prolong the life of the infrastructure.

The PMU has indicated that the PPC intends to establish a state owned enterprise to operate and maintain sewerage and drainage systems in Dong Nai province. This new company, named Dong Nai Sewerage and Drainage Company (SDCO) would be responsible for all aspects of sewage and storm water management including planning, design, construction, operation and maintenance.

In Viet Nam there are 4 companies that specialize in delivering sewerage and drainage services. These are located in the cities of Ha Noi, Ho Chi Minh, Hai Phong, and Ba Ria Vung Tau (ADB report TA.4903-VIE Water Sector Review 2007).

Sewerage and drainage services are also delivered in three other ways in this country.

- There are 36 urban infrastructure companies such as URENCO that provide drainage services in combination with solid waste collection, street management, parks, lightings, and cemeteries/cremation (but not sewage management).
- There are 32 water supply companies that are also responsible for drainage/sewarage
- There are 49 companies that focus on drainage only. [not including sewerage]

Responsibility for managing the new sewerage system could be given to the Water Supply Construction Company or to URENCO however both companies are busy with a number of new capital projects and are struggling to keep up with the demand for services caused by rapid urban growth. Both companies are facing enormous challenges as they plan for the future.

JICA Study Team recommends that a new entity be created to manage the operation and maintenance of new sewerage systems. This should include combined sewers and storm water pipes where they exist within the project area because the equipment for cleaning and inspecting is the same. Staffing requirements for the project do not include the maintenance of storm water collection systems outside the project area (i.e. pipes and concrete channels).

Sewerage systems are relatively new in Viet Nam and operators would require a considerable amount of training. JICA Study Team recommends that the new entity focus solely on learning the sewerage management business in order to improve the project’s chances of success. As such, maintenance of the open channel drains and canals should in the Study team’s opinion continue to be managed by URENCO, since they already have the manpower and the task is relatively straight forward (related to removing accumulated solid waste). At the request of PMU, staffing and equipment for maintaining open channel drains improved under the project have been included since this function must be improved regardless of which entity ultimately takes on the responsibility.

7.5.2 Scope of Facilities for Operation and Maintenance

Recommendations on organization, staffing and equipment contained in this report are for the operation and maintenance of the infrastructure components created or improved under the proposed project as well as existing storm water drainage systems in the project area. In addition JICA Study Team has included the requirements for managing the collection of septic tank sludge for the whole City of Bien Hoa. The scope of the infrastructure provided under the project is as follows:

(1) Sewage disposal system:

- Treatment plant STP2 : 52,000 m^3/d
- Main pumping stations : 2
- Manhole pumping stations : 25
- Main trunk sewers : 12 km
- Branch sewers : 42 km
- Tertiary sewers : 203 km
- Interceptor sewer : 6 km

(2) Storm water sewer

- Main storm sewers for separate area : 45 km
- Main storm sewers for combined area : 10 km
- Branch storm sewers : 111 km

(3) Open channel drains : 15 km

7.5.3 Requirements for Effective Operations and Maintenance Management

To operate and maintain sewerage and drainage services, the operator must have proper facilities and equipment and know in detail what they are working with in terms of the collection system as a whole as well as its individual equipment and parts. It must also have a vigilant preventive maintenance schedule and regularly assess if the existing infrastructure is keeping up with changing conditions and demand. These all help to identify problems then the operator must set priorities and have well trained personnel to deal with them.

(1) Adequate Maintenance Facilities and Equipment

Maintenance facilities are locations where equipment and materials are kept and repaired and from where network maintenance workers are dispatched. A properly planned and supported equipment yard is an essential starting point for the entire operation. It would need to be sufficiently large to accommodate sewer maintenance vehicles, sewer maintenance equipment, maintenance workshop, stores and staff facilities such as lockers and showers. The Study team proposes that at least one maintenance yard be located at the sewage treatment plant. Another smaller satellite yard may also be required for some of the network maintenance crews to minimize travel times.

(2) Equipment and Replacement Parts Inventories

A process for identifying critical parts is needed for system operation, as well as maintenance of an inventory of replacement parts. This would greatly facilitate timely response to breakdowns or malfunctions and thus avoiding extended service outages for customers. If there is a good preventive maintenance program, the emergency supplies could be kept to a much lower level.

(3) Maintenance of a Collection System Map

One of the most typical problems in collection system management and maintenance is determining the locations of sewer lines and manholes. Many agencies have large collection system maps divided into overlapping, large-scale sections that can be bound into books. These can be stored easily and taken into the field as needed. Maps and plans should be kept current by updating them when alterations or system additions occur. The use of GPS to accurately measure the location of collection system components is increasing.

GIS has made the mapping and map updating process considerably more efficient. GIS is a computerized mapping program capable of combining mapping with detailed information about the physical structures within the collection system as well as historical information including video imaging of the pipe and manhole interiors.

(4) Routine Preventive Maintenance Activities

A good preventive maintenance program is one of the best ways to keep a system in good working order and prevent service interruptions and system failures which can result in overflows and/or backups. A preventive maintenance program also protects the capital investment.

Preventive maintenance activities should ensure that the system operator:

- Routinely inspects the collection system, including pump stations, and addresses defects or other problems.
- Investigates complaints and promptly corrects faulty conditions.
- Keeps maintenance records, an adequate workforce and all equipment in working order.
- Maintains and updates a schedule of planned activities.

Preventive maintenance activities typically conduct:

- Planned, systematic, and scheduled inspections to determine current conditions and plan for maintenance and repairs.

- Planned, systematic, and scheduled cleaning and repairs of the system based on past history.
- Proper sealing and/or maintenance of manholes.
- Regular repair of deteriorating sewer lines.
- Remediation of poor construction.
- Inspection and maintenance of pump stations and other appurtenances.

(5) Program to Assess the Capacity of the Collection System and Treatment Facilities

A critical function of the collection system is to provide adequate capacity for sewage flow. The capacity needs of a collection system change as the system ages, new connections are made, and existing connections change their water usage. Identifying reserve capacity, hydraulic deficiencies, and capacity needs is critical for effective asset management. The capacity assessment program should have established procedures for:

- Determining whether adequate capacity exists in downstream portions of the network.
- Collection system and treatment facilities that would receive sewage from new connections.
- Identifying existing capacity deficiencies in the collection system and at treatment facilities.

(6) Identification and Prioritization of Capacity and Structural Deficiencies and Corresponding Rehabilitation Actions

Sanitary sewers are exposed to harsh internal and external environments. Structural condition assessment is a principle objective of any pipeline system inspection program and is important to cost-effective management of the collection system. The system operator should clearly identify the techniques used in the program, such as field inspections or closed-circuit television, identify areas of the collection system where various measures are employed, and describe criteria for identifying priorities for inspection and for correction.

(7) Training

Sewerage system employees must be well trained in standard operating and maintenance as well as safety procedures. Formal and organized training programs are essential regardless of agency size. Regular refresher courses and special up dates on new equipment and procedures should also be considered.

7.5.4 Proposed Organizational Structure for O&M

The proposed organizational structure for the new O&M entity is presented in Figure 7.5.1. It is based in part on *Institutional and Organizational Guidelines for Wastewater Management Companies, (Hanoi 2009)* developed by GTZ for the Wastewater And Solid Waste Management In Provincial Centers project.

The structure reflects the following organizational objectives:

- to provide an organization that is responsive to the public
- to deliver services cost effectively while minimizing the impact of sewage on the environment
- to maintain and prolong the life of the assets

Daily operations and maintenance activities would be carried out by the Network Management Division and the Wastewater Treatment Division. These two operating divisions would be supported by the technical services, finance, administration and customer relations functions. Divisions are broken down into specialized units based on functional responsibilities. The proposed staffing levels are for the project which provides services to a population of 188,000.

Additional operating divisions and support staff would be needed in the future as the collection system expands and more treatment plants are added.

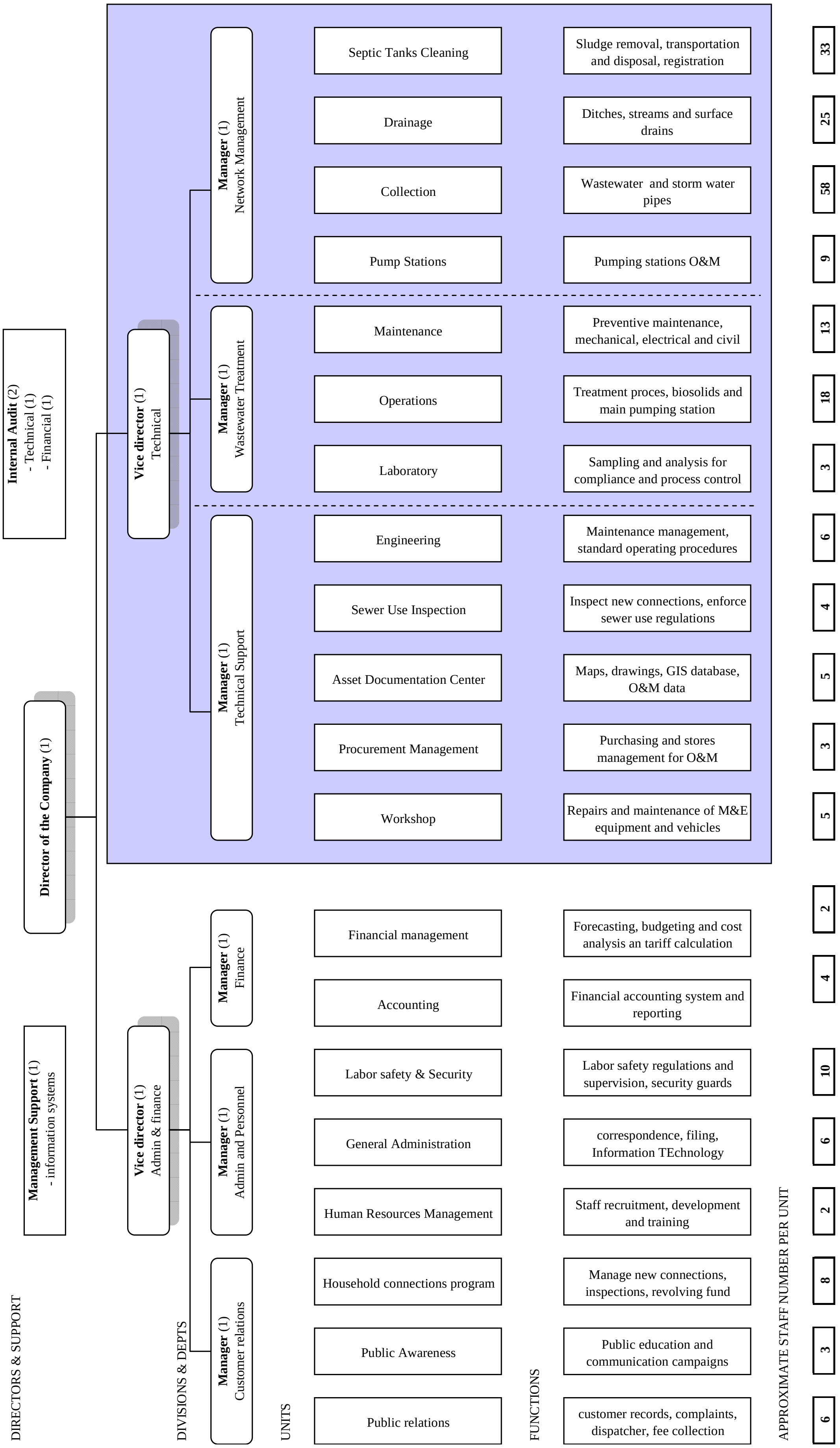


Figure 7.5.1 Proposed Sewerage and Drainage Company Organizational Chart

(1) Network Management Division

The network management division would be responsible for all aspects of sewage and storm water collection. Network Management is subdivided into 3 units as follows:

1-1) Septic Tank Sludge Collection Unit

Responsible for collecting sludge from septic tanks and transporting it to the treatment plants for processing.

1-2) Collection System Unit

Responsible for the sewage and storm water conveyance systems. Maintenance work includes annual cleaning and inspection of sewage and storm water sewer pipes as well as routine work relating to manholes and inspection chambers. Crews also respond to emergency situations where sewer mains become blocked or collapsed.

1-3) Drainage Unit

Responsible for ditches, stream and concrete covered channels. Maintenance work includes inspection, repair, flushing and cleaning to prevent flooding.

1-4) Pump Stations Unit

Responsible for ensuring that all sanitary pump stations located in the collection network are operating to keep sewage moving to the treatment plants for processing.

(2) Wastewater Treatment Division

The wastewater treatment division would be responsible for all aspects of sewage treatment including septic tank sludge and bio-solids produced by the treatment process. The treatment division would have 3 sub-units as follows:

2-1) Operations Unit

Responsible for controlling and adjusting wet and dry unit processes, optimizing plant performance and operating in compliance with the plant’s discharge permit.

2-2) Maintenance Unit

Responsible for maintenance of electrical and mechanical process equipment and instrumentation including the pumping station located at the treatment works.

2-3) Laboratory Unit

Responsible for sampling and testing for process control and compliance with the plant’s discharge permit.

(3) Technical Services Division

The Technical Services Division would provide technical support to the operating and maintenance divisions. Most of the measures identified for effective operation and maintenance would be carried out by the technical services division. The Technical Services Division would have the following 5 units:

3-1) Engineering Unit responsible for:

- overseeing maintenance management systems and information,
- developing standard operating procedures,
- implementing flow monitoring studies and modeling of the collection system to assess capacity and correct hydraulic deficiencies (item 5 - Measures for Effective O&M)
- assessing the structural condition of sewers, identifying priorities and planning rehabilitation (item 6 - Measures for Effective O&M)

3-2) Sewer use Inspection Unit responsible for:

- Implementing a program to ensure that new sewers and connections are properly designed, inspected and constructed and new connections of inflow sources are prohibited.
- Implementing a program to oversee lateral and private collection system installations that tie in to public sewage collection systems.
- Implementing a program to eliminate existing illegal inflow sources and working with the Public Awareness Unit on a strategy for informing and educating the public about such sources.

3-3) Asset Documentation Unit responsible for:

- Maintaining accurate, up-to-date maps and GIS database of the collection system including a registry of septic tanks and sewer connections (refer to item 3 - Measures for Effective O&M).
- Maintaining as-built drawings, and information on M&E equipment such as servicing manuals, parts lists, and manufacturers recommended procedures.

3-4) Procurement Management Unit

Responsible for identifying critical parts needed for system operation, and maintenance of an adequate inventory of replacement parts (Refer to item 2 - Measures for Effective O&M).

3-5) Workshop Unit

Responsible for maintenance of sewer cleaning equipment, vehicles and plant equipment such as motors and pumps (Refer to item 1- Measures for Effective O&M). Specialized maintenance or repairs should be outsourced because it is generally more cost effective.

(4) Finance and Accounting Division

This division establishes budgets, monitors actual expenditures against budget targets, and prepares financial reports for management’s review including cost analysis and tariff calculations.

(5) Administration and Personnel Division

This division is responsible for recruiting staff, training, establishing information technology systems, ensuring worker safety and facilities management functions such as janitorial and security guard services, and other related administrative duties.

(6) Public Relations Division

This division provides a single point of contact with the public. This division would have the following 3 units:

6-1) Customer care unit

Maintains customer records and is responsible for dealing with customer complaints. Customer care is available 24 hours 7 days a week to dispatch maintenance crews in response to emergencies such as blockages and overflows.

6-2) Public Awareness Unit

Deals with the media, and implements public communication and education campaigns. The unit promotes sewer connections, good sewer use practices and environmental awareness.

6-3) Household connections Unit

Manages the sewer connection program. The unit processes requests for new connections, deals with allocation of grants and administration of the revolving fund, provides households with technical information on how to connect and inspects new sewer connections.

7.5.5 Operation and Maintenance of Collection Networks and Pumping Stations

(1) Tasks

The following sections outline the methods and equipment used to inspect and clean gravity collection systems and pumping stations. Frequent inspection and cleaning is essential for normal functioning and problem identification.

1-1) Wastewater Collection network

Typical maintenance problems encountered with gravity systems include accumulation of silt, sediment, rags, grease, and building debris. Sludge accumulation leads to blockages, flooding and septic conditions that cause odors.

Typical preventive maintenance activities include:

- regularly scheduled inspection and cleaning of sewer pipes
- emergency cleaning to remove blockages
- regular and emergency repairs to manholes and sewers
- inspection and installation of sewer connections

Frequent physical inspection is vital to a good O&M program. Routine scheduled inspection of the entire sewage collection system is required to verify the condition of the system so that blockages and overflows can be prevented. Every year, about 20% of the network should be systematically cleaned and inspected by CCTV camera.

Repairs to sewers and manholes would be needed on an annual basis to maintain the structural integrity of the sewerage systems, to reduce infiltration into the system and leakage from the system.

Old service connections should be checked at a rate of about 20 to 30% per year. New service connections should be installed as required.

1-2) Storm water collection network

Storm water is collected in pipes and concrete box channels covered with concrete lids. A typical problem is the accumulation of solid waste. Typical maintenance activities include:

- replacing broken lids on concrete covered channels
- repairing concrete channels damaged by vehicles
- regularly scheduled inspection and cleaning of sewer pipes and channels
- inspection and cleaning of street inlet grates

1-3) Open channel drains

Open channel drains include ditches and streams. Typical problems include accumulation of solid waste and sediment that lead to reduction in capacity and in some cases flooding.

Typical preventive maintenance activities include:

- Removing garbage from open drains on a regular annual basis before the rainy season
- Removing accumulated sediment from open drains on a regular basis
- Maintaining rights-of-way along drains to prevent encroachment by illegal building activities and squatters.

1-4) Pump Stations

The primary objective of operating and maintaining a pump station is to keep the station in continuous operation in order to prevent sewage overflows to the environment and flooding in upstream reaches of the incoming sewers.

The operation of pump stations is usually automated and does not require continuous on-site operator presence. Maintenance tasks would typically consist of the following activities:

- daily monitoring of pump operations and responding to abnormal conditions
- daily removal of screenings and grit from the inlet works
- periodic removal of silt from the intake well
- regular preventive maintenance of mechanical and electrical equipment
- repairing of motors and pumps in case of emergency breakdowns
- occasionally cleaning the pressure main

Pressure mains are very reliable when they are properly designed and maintained. However, annual pressure main route inspections are recommended to ensure normal functioning and to identify potential problems. The most common method of cleaning pressure mains is the use of polyurethane swabs.

(2) Staffing Estimates

Estimates for the amount of staff necessary to operate and maintain the sewage collection and piped storm water drainage systems are based on EPA's 1974 publication "*Manpower Requirements for Wastewater Collection Systems in Cities of 150,000 to 500,000 in population*".

2-1) Sewage and Storm water Collection Network

Staffing estimates in the Table 7.5.1 are for a service population of 200,000 and have been adjusted based on experience with similar projects of this size.

Table 7.5.1 Staffing Estimates for Sewage & Storm Water Collection Network Mtce.

Function	No. of Crews	Staff per crew	Occupation	No.	Sub-total
Management			Maintenance superintendant	1	3
			District supervisor	2	
District A - network mtce**.**					20
Patrol crew	1	2	Maintenance worker	2	
Cleaning crews	3	1	Equipment operator (Jetting, etc.)	3	
		1	Maintenance worker	3	
Minor repair crew	1	1	Foreman	1	
		2	Maintenance worker	2	
		1	Laborer	1	
Major repair crew	1	1	Foreman	1	
		2	Maintenance worker	2	
		2	Laborer	2	
Masonry crew	1	2	Mason	2	
		1	Laborer	1	
District B - network mtce**.**	same as district A			20	20
Labor and Equipment Pool			Equipment supervisor	1	11
	3	1	Equipment operator (Backhoe)	3	
		1	Vehicle operator (Dump truck)	3	
	2	2	Laborer	4	
TV inspection	1	1	TV technician II	1	4
		1	TV technician I	1	
		2	Maintenance workers	2	
				Total	58

Maintenance crews are assigned to two districts. Each district has:

- One sewer patrol crew that conducts a regular inspection of collection facilities, submits inspection reports describing deficiencies and their causes, and recommended corrective action, including preliminary cost estimates of required repairs or maintenance.
- Three cleaning crews deploying sewer cleaning equipment such as hydraulic jetting, power rodding and bucket machines. Most sewer cleaning equipment requires a crew of two except the bucket machine which requires a crew of three.

- One major repair crew, one minor repair crew for pipes and one masonry crew that repairs manholes and resets covers.

There are certain cross cutting functions that are more efficiently managed centrally rather than be assigned individually in each district:

- Equipment operators' pool: provides heavy construction equipment and trucks with construction equipment operators and automotive equipment operators to support various repair activities.
- Laborer pool: provides additional laborers to various crews when needed, such as sewer cleaning with bucket machines.
- TV Inspection Crew: involved in the internal inspection of sewer lines

The staffing estimates are based on a preventive maintenance concept which requires sufficient manpower be allocated to perform scheduled preventive maintenance as opposed to emphasis on emergency responses. It is also assumed that new and major construction of storm and sanitary sewer lines would be done by outside contractors and that the maintenance of lateral lines connecting households would be the responsibility of the private property owner.

2-2) Open channel drains and concrete covered drains

The project would improve approximately 15 km of open channel drains. These drains would be maintained on an annual basis. About 22 km of concrete covered drains are presently maintained by URENCO; the Study team estimates that about 50% of these are in the project's storm water collection area.

Table 7.5.2 Staffing Estimates for Maintenance of Open Channel Drains

Function	No. of Crews	Staff per crew	Occupation	No.	Sub-total
Management		1	Supervisor	1	1
Open Channel Drains.					12
Cleaning crews	3	1	Foreman	3	
		2	Laborer	6	
Ditch dredging machine	1	1	Equipment operator	1	
Dump truck	1	1	Equipment operator	1	
Excavator	1	1		1	
Concrete covered drains					12
Cleaning crew	3	1	Foreman	3	
		2	Laborer	6	
Repair crew	1	1	Foreman	1	
		2	Masons	2	
				Total	25

2-3) Pumping stations

Manpower estimates for pumping stations are not related to the size of the population served. They are based on the number of pumping stations to be maintained which in the proposed priority project I would number near 25. For small capacity pumping stations (less than $22m^3$/min) one M&E crew consisting of a mechanic, an electrician and two helpers would normally be able to provide routine preventive maintenance for up to 8 pumping stations per day including travel time. Therefore 1 crew should theoretically be able to maintain up to 40 pumping stations (8 visits per day x 5 days per week). The overhaul and repair of pumps and equipment requires one additional senior mechanic and helper for every 15 pumping stations. Larger pumping stations if they are constructed would require additional staff.

Table 7.5.3 Staffing Estimates for Operation & Maintenance of Pump Stations

Function	No. of Crews	Staff per crew	Occupation	No.	Sub-total
Management			Supervisor	1	1
Pump overhaul & repair	2	1	Mtce. Mechanic II	2	8
		1	Mechanic's helper	2	
Routine mechanical	1	1	Mtce. Mechanic I	1	
		1	Mechanic's helper	1	
Routine electrical	1	1	Electrician	1	
		1	Electrician's helper	1	
				Total	9

Note: pump station 5 located at the treatment plant would be maintained by treatment plant staff

(3) Specialized Sewer Maintenance Equipment

Maintenance requirements for storm water collection pipes are similar to those of sewerage systems and similar equipment can be used for inspecting and maintaining both systems.

The equipment and methods used to clean sewers generally depends on the diameter:

- Small diameter sewers (150 mm to 400 mm) can be cleaned hydraulically using high pressure jetting machines to wash accumulated sludge to a downstream manhole where it is removed by a vacuum suction truck. They can also be cleaned mechanically using power rodding machines to scrape and cut obstructions such as roots.
- Larger diameter sewers (400 mm - 1100 mm) are usually cleaned by winching a bucket through the sewer line to capture and remove debris.
- Large diameters (greater than 1100 mm) are cleaned by manual de-silting.

Cleaning is usually combined with visual inspection of the condition of the pipe, using closed circuit television (CCTV).

The following specialized equipment has been included in project costs for collection system maintenance:

Table 7.5.4 Sewer Maintenance Equipment Included in the Project

Equipment	Purpose	Q'ty
High-pressure jetting machine	Sewer cleaning	2
Vacuum truck	Sewer cleaning	2
Tanker truck	Sewer cleaning	2
Power Rodding machines	Sewer cleaning	2
Power Bucket machine	Sewer cleaning	2
CCTV truck	Inspection	1
Stop plugs assorted diameters	Inspection	6
Maintenance Vehicles	Transport Mtce. Crews	14
Backhoe	Major repairs	2
Dump truck	Major repairs	2
Crane truck (4 ton)	Lift heavy equipment e.g. pumps	1

(4) Equipment for Cleaning Drains

Smaller shallow drains are often not easy to access with mechanized equipment and would be cleaned manually with shovels and buckets winched along the bottom of the drain to an extraction point where a small excavator could be used to remove the debris.

Deeper channels would be cleaned and dredged using a specialized grading machine (Gradall Xl3200) equipped with a telescopic boom and a dredging bucket. This type of machine can operate in a very tight space and has a relatively long reach of 5.8m.

Concrete covered drains are easy to access and can be cleaned manually with shovels and flushed using a low pressure tanker truck. A hoist truck is required to assist in lifting concrete covers. Solid waste removed from the drains would be placed in containers provided by URENCO.

The following specialized equipment is included in the project cost estimate:

Table 7.5.5 Open Channel Dredging and Cleaning Equipment

Equipment	Purpose	Q'ty
Low pressure flushing truck	Cleaning concrete drains	1
Hydraulic excavator – with 1.8m dredging bucket	Dredging and grading open channels	1
Dump truck	Disposal of garbage and dredged silt	2
Crane truck (2 ton)	Lift concrete covers	1

7.5.6 Septic Tank Sludge Collection

A large percentage of the population in Bien Hoa City would be living outside the area serviced by the sewerage project and would continue to rely on septic tanks for sewage disposal. Householder neglect is often a significant contributor to poorly performing systems that contribute high pollutant loads to the environment. By adopting a managed maintenance programmed for septic tanks, such poor performance may be prevented, and the system life extended significantly.

(1) Tasks

In the short term, the only way to implement regular cleaning and proper disposal of septic tank sludge is to make it mandatory and assign management responsibility to the public sewerage management entity. Therefore a septage collection unit is proposed. The unit would be responsible for overseeing all issues related to septic tanks including the following primary tasks:

- Creating and maintaining a registry of septic tanks
- Collecting and transporting sludge from septic tanks to the sewage treatment facility
- Scheduling regular cleaning (2 year cycle)
- Collecting fees for service (if these are deemed applicable)

The septage management unit would consist of two functional sub-units:

- monitoring
- collection/transportation

1-1) Monitoring

The monitoring sub-unit would be responsible for approval of new construction, septic tank registration and septic tank inspection. The monitoring unit would develop a GIS based registry of septic tanks in order to keep a record of each installation and to schedule regular cleaning. Establishing a database would require a baseline survey of septic tank installations throughout the city, including the proposed sewage management area.

1-2) Collection

The collection/transportation sub-unit would be responsible for removing sludge from septic tanks on a regular cleaning cycle and transporting the sludge to the sewage treatment facility. Septic tanks would typically be cleaned using conventional vacuum trucks with a tank capacity of 3 to 6 m^3 however smaller trucks and some specialized portable tanks may be required to access narrow lanes. A total of 11 vacuum trucks have been included in the project's cost estimate. The number of trucks is based on cleaning all septic tanks inside and outside of the project area on a 2 year cycle (refer to chapter 4 – planning basis for details).

(2) Staffing Estimates

Table 7.5.6 Staffing Estimates for Collection of Septic Tank Sludge

Unit/sub-unit	Function (crews)	Occupation	No.
Septic Tank Sludge Unit	Manages the unit	Superintendant	1
Collection sub-unit	Supervise work crews	District supervisor	3
	Suction truck crews (11)	Equipment operator	11
		Maintenance worker	11
Monitoring	Manager	Engineer	1
	GIS database	Technologist	1
	Registry & schedule	Clerk	2
	Inspectors	Technologist	3
		Total	33

7.5.7 Operation and Maintenance of STP2

(1) Staffing Estimates

Staffing estimates for the proposed activated sludge treatment plant are derived from “The Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants” prepared by the New England Interstate Water Pollution Control Commission November 2008. Available as a free download through NEIWPCC’s Web site, the guide features a series of charts enabling a user to calculate the number of staff hours required daily to complete various operating and maintenance tasks (excluding management).

Table 7.5.7 Estimated Staff Hours per Day for O&M Activities at STP

Activity/Process	Processes / No. of units	Daily Hours per unit	Hours/day
Process Operations – liquid		**Sub-total**	36.25
Preliminary treatment process	1	3	3
Primary clarification process	16	1	16
Activated sludge with Biological Nitrogen Removal	1	12	12
Nitrification	1	1	1
Denitrification	1	1	1
Plant re-use water system	1	0.25	0.25
UV disinfection process	1	1	1
Odour control system (Dry)	2	0.5	1
Septage receiving facilities	1	1	1
Process Operations - Sludge Handling		**Sub-total**	17
Gravity thickening process	1	1	1
Mechanical dewatering process (screw press with polymer)	1	8	8
Transportation off-site for disposal	1	8	8
Maintenance		**Sub-total**	44.35
Manually cleaned screens	3	0.5	1.5
Mechanically cleaned screen	2	3	6
Gravity grit removal channels	2	0.25	0.5
Tank for receiving septage	1	0.25	0.25
Chemical addition (# of chemicals)	2	0.45	0.9
Chain and flight clarifiers	16	0.75	12
Mixers	16	0.15	2.4
Blowers	16	0.30	4.8
Gravity thickening basins	4	0.30	1.2
Mechanical dewatering (screw press machines)	6	0.40	2.4
Ultraviolet disinfection	42	0.25	10.5
Activated carbon units	2	0.75	1.5
Probes/Instruments/Calibration (# of different types)	4	0.1	0.4
		Total	97.6

Table 7.5.8 Annual Allowance for Pump Maintenance and Yard Work at STP

Activity		Hours per year
Yard work	Sub-total	1,120
Janitorial/Custodial Staff		400
Mowing		400
Facility Painting		160
Rust removal		160
Pump Maintenance: Estimated time to maintain all pumps at the treatment plant		750

Table 7.5.9 Estimated Staff Hours for Laboratory Operations

Laboratory Operations	Frequency per year	No. of tests per timeframe	Hours per test	Hours per year
Acidity	52	1	0.75	39
Alkalinity, total	52	1	0.75	39
Biochemical Oxygen Demand (BOD_5)	52	5	2.50	650
Chemical Oxygen Demand (COD)	52	5	2.50	650
Coliform, Total, Fecal, E.Coli	52	1	1.00	52
Dissolved Oxygen (DO)	52	5	0.25	65
Hydrogen Ion (pH)	52	1	0.25	13
Ammonia	52	1	2.00	104
Total Nitrogen	52	1	2.00	104
Oil and Grease	52	1	3.00	156
Total and Dissolved Phosphorus	12	1	2.00	24
Solids, Total, Dissolved, and Suspended	52	5	3.00	780
Sulfate	52	1	1.00	52
Lab QA/QC Program	12	1	1.00	12
Process Control Testing	52	5	3.00	780
			Total	3,520

The hourly estimates provided by the guide assume that the tasks are performed by “fully trained” operators. Those who are less than fully trained in a task would typically take longer or would perform in a less than effective manner. When using the guide, therefore, it is necessary to adjust the estimates based on the training of a plant’s existing staff and those to be hired.

Daily hourly estimates are converted into yearly estimates according to the number of personnel shifts per day. Three options are presented for comparison as follows:

- One Shift Plant: A facility that has one shift a day, five days a week. The daily hour estimates would be multiplied by 260 to arrive at annual hours.
- 24/7 Plant: A facility that is staffed seven days a week, twenty four hours per day. The daily hour estimates would be multiplied by 365 to arrive at annual hours.
- One-Plus Shift Plant: Any facility whose staffing schedule does not fit into the previous two categories may have one shift a day, seven days a week; or perhaps one shift a day, five days a week, with a reduced number of staff on weekends. The daily hour estimates would be multiplied by 320 to arrive at annual hours.

Table 7.5.10 - Estimated Staff Hours on Annual Basis

Activity	1 shift 260 days per year	1 plus shift 320 days per year	24/7 365 days/year
Process operations - liquid	9,425	11,600	13,231
Process operations – solids*	5,304	5,304	5,304
Maintenance	1,1531	14,192	16,188
Pump maintenance*	750	750	750
Laboratory **	3,520	3,520	3,520
Yard work**	1,120	1,120	1,120
Total	31,650	36,486	40,113

Notes: * annual requirement for operating 6 days per week
** annual requirement for maintaining all pumps at the treatment plant
*** annual requirement 5 days per week

Table 7.5.11 - Estimated Number of Employees Based on Annual Hours

Activity	1 shift (No. of staff)	1 plus shift (No. of staff)	24/7 (No. of staff)
Process operations - liquid	7	8	9
Process operations - solids	4	4	4
Maintenance	8	10	11
Pump maintenance	1	1	1
Laboratory	3	3	3
Yard work	1	1	1
Total	24	27	29

Note: assumes 1500 hours per person (a five-day work week per employee; 6.5 hours of productive work per day; and an average of 29 days for holidays, vacations, and sick leave).

The Study Team recommends that the treatment plant be operated with one full shift 5 days a week and a reduced number of staff at night and on weekends (i.e. a one-plus shift plant). Sludge handling operations would be 6 days a week.

The staffing estimates prepared according to the guide are adjusted to include management staff and to reflect the Study Team's experience with similar treatment plants in other projects. Recommended staffing levels are as follows:

Table 7.5.12 Recommended Number of Employees for Sewage Treatment

Function	Position	No.	Sub-total
Operations	Superintendant - liquid process	1	18
	Superintendant - biosolids process	1	
	Process control engineer	1	
	Process control technicians	3	
	Process operatives - liquid	4	
	Process operatives - solids	2	
	Drivers – sludge disposal*	6	
Maintenance	Mtce. Mechanic	3	13
	Mtce. Mechanic helper	3	
	Electrician	1	
	Instrument technician	1	
	Laborer	3	
	Yard Maintenance Worker	2	
Laboratory	Chemist	1	3
	Lab technician	2	
		Total	34

Note * based on the calculation of sludge quantity.

7.6 Capacity Building

The lack of experienced and qualified personnel on a national basis in the sewerage sector is a serious constraint to the operation and maintenance of the sewerage systems. Finding suitable management candidates with operational experience and technical personnel with the required skills is always a problem. Training and capacity building is needed to meet this challenge.

Training and capacity building activities would be carried out at different stages of project as follows:

- Technical Assistance at the pre-construction stage to finalize the organizational structure, develop job descriptions and define required skills and qualifications.
- Executive management training for project steering committee members, key decision/policy makers and key executives of the project implementation team during the detailed design stage.
- Initial training for project implementation staff during the pre-construction stage.
- Job-related, academic (class room) training for O&M staff during project construction.
- Job-specific, hands-on training during the commissioning period, and
- Technical assistance for operating the treatment plant, pumping stations and collection system for a period of at least 12 months after project completion.

Training would be delivered by international and Vietnamese experts in collaboration with local environmental technology institutes. Courses would cover technical, operational, financial and management aspects of the sewerage sector.

(1) Assistance at the Pre-construction Stage

The PMU would require assistance at the pre-construction stage to recruit staff for the operation and maintenance of the project. Tasks assigned to a specialist consultant at this stage would include:

- To finalize staffing numbers and the organizational structure
- To develop job descriptions
- To define the required skills and qualifications for each job

Job descriptions are the basis for developing the training program. They describe the specific skills and educational backgrounds required for the positions in the organization. Some typical positions include:

- STP operator
- Treatment process control engineer
- Treatment plant superintendent
- Crew leader/supervisor

- Laboratory analyst/technician
- Maintenance mechanic
- Maintenance electrician

The development of job descriptions would be guided by similar positions found in established agencies such as the Dong Nai Water Supply and Construction Company and the Ho Chi Minh Sewerage and Drainage Company.

(1) Executive Management Training

Key executives have an important role to play in preparing the project and implementing the project including financial arrangements, coordination with relevant authorities, implementing regulations, establishing the O&M organization. Training courses would be aimed at introducing the fundamentals of modern management models and their applications to sewerage services. Topics would include:

- Roles and responsibilities
- managerial and organizational systems
- strategic planning for public service delivery,
- private sector participation,
- least cost analysis
- cost recovery practices and commercial principles,
- tariff structures
- sewer use by-laws
- procurement of construction
- environmental consideration and monitoring
- Public relations
- Planning, design, and technical background
- Effective operation and maintenance

A number of executives (10) would be selected for study tours to operational facilities in other countries to expose them to best management practices. Two separate study tours would be arranged by the training consultant, each tour lasting approximately 2 weeks. Study tours would include lectures, short seminars and site visits.

(2) Initial Training

Some of the key middle management and technical positions at the new operating entity would likely be filled by PMU staff involved with project design and implementation. JICA Study Team recommends that capacity building begin at the detailed design stage to ensure that all key personnel would be better prepared to make the transition to operation and maintenance of the system. Capacity building would best be delivered by including the PMU in design activities like developing base maps, using software programs for calculating sewage flows and preparing collection network drawings.

Training courses would be aimed at developing their technical knowledge of sewerage systems. Course materials would emphasize the implications of design choice and equipment selection on O&M requirements. This would improve staff's ability to provide substantive input during the design stage of the project.

Topics would include:

- Forecasting sewage and storm water flows
- Least cost analysis
- Project management
- Treatment plant design, operation and maintenance
- Collection system design, operation and maintenance

A number of PMU staff (4) would be selected for visits to operational facilities in other countries to expose them to best management practices. Three month visits would be arranged by the training consultant. The trainees would attend lectures and participate in site visits and job-shadowing.

(3) Job Related Training

O&M staff including managers should be hired before the completion of the project with sufficient lead time to allow on the job training and to ensure a smooth transition during facility testing and commissioning. A phased recruiting process would take place over the 2 years before the construction of the treatment plant is completed. Job related training would provide the specific knowledge required by the position. This training would not be facility specific, covering standard practices used in most collection systems and treatment facilities. This core of related knowledge represents the knowledge base of the "need-to-know" criteria most certifying agencies used for examinations and certifications. Typical job-related training courses would be as follows:

a. Technical

- Forecasting sewage and storm water flows
- Purpose and fundamentals of sewage treatment
- Treatment plant hydraulics
- Collection system and pump station design

b. Operational

- Operation/maintenance of activated sludge treatment plants
- Sewer cleaning and managing grease blockages
- Collection system evaluation, rehabilitation and performance assessment
- Preventive maintenance management
- Automation and telemetry
- Preventive maintenance
- Laboratory analysis and quality assurance
- Occupational health and safety for construction and operation

c. Management

- Best practices for operation and maintenance
- Asset management and documentation systems
- Setting up maintenance management systems
- Communications and public relations

d. Financial

- Least cost analysis to plan and design projects
- Financial projections and analysis
- Tariff analysis

(4) Job-specific Training

Job-specific training covers the various tasks associated with the position. These tasks may range from repair of a pump to the reconfiguration of the treatment process. Job specific training would be developed for processes at the treatment plant and maintenance tasks in the collection system. Training modules would include the following aspects of carrying out O&M activities:

- Health, safety and environmental considerations
- Process start-up and shutdown
- Normal operations
- Routine checks
- Alternate and emergency operations

Job-specific training would be implemented during the commissioning stage to supplement the O&M training received from the contractor for specific equipment. Training would be hands-on, and based on standard operating procedures developed for the project.

Typical job-specific training modules would be as follows:

a. Treatment plant operations:

- Pump O&M
- Aeration Blower O&M
- Clarifier O&M
- Sludge dewatering machine O&M
- Odor control system O&M
- UV disinfection O&M
- Instrumentation O&M
- Valves O&M
- Process control (individual modules for each unit process)
- Lab analysis for process control

b. Collection system

- Pump O&M
- Odor control systems
- Sewer cleaning equipment (individual modules for each type of equipment)
- CCTV inspection
- Manhole repairs
- Pipe fitting and repairs
- Septic tank sludge collection

c. Health and safety

- Confined space entry procedures
- Safe work permit process
- Electrical safety
- Traffic safety
- Excavation safety

(5) Technical Assistance with Treatment Plant Operations

The operating entity would need on-going technical support after project completion. The initial learning curve would be steep and most facilities usually encounter some start up problems.

In estimating the costs for capacity building JICA Study Team have assumed that technical assistance would be provided by an international consultant specializing in the operation and maintenance of sewerage facilities.

Another option would be to involve the private sector in the management of the STP. Management contracts for major facilities are useful when local manpower or expertise capable of running the facility is limited. A management contract could serve as a transitional arrangement, while the public authority receives on-the job training and develops the expertise required to take over the operation.

(6) Capacity Building Costs

Capacity building cost estimates are based on the estimated number of courses to be delivered at different stages of the project, and assuming that most of the courses would be delivered by foreign experts with the assistance of local resources if these are available. Some of the job-specific training could be included in the construction contract.

The number and duration of courses to be offered at each stage of the capacity building program is prepared for cost estimation and is presented in Table 7.6.1.

Table 7.6.1 Estimated Number of Training Modules

Proposed Training Activities	No. of people trained	# of Course modules	Days/ module	Trainer days	MM
Executive seminars - local	20	8	3	24	1.0
International visits	20	2	2	4	0.2
Initial training for PMU - local	10- 15	8	5	40	1.7
International exposure visits	4	4	5	20	0.8
Job-related training - local					
management	10	5	10	50	2.1
treatment	20	8	10	80	3.3
collection	30	8	10	80	3.3
Job-specific training - local					
treatment	25 - 35	8	3	24	1.0
collection	40 - 60	12	3	36	1.5
health and safety	130 - 160	16	2	32	1.3
			sub-total	342	16.3

The timing for the training, the actual number of persons trained and the design of the training program would depend on when people are hired and what kind of skills they have. These factors would be assessed by the consultant when designing the capacity building program. Estimates of the total costs to deliver the O&M capacity building program are presented in Table 7.6.2.

Table 7.6.2 Cost Estimate for O&M Capacity Building

Item	Activities	Estimated cost VND (million)	Estimated cost US$	Remarks
Pre-construction technical assistance - finalize org chart & staffing - develop job descriptions - develop training program - develop training materials	Foreign Consultant	7,573	400,000	US$ 40,000/p/m including per diem
	Local Consultant	0	0	US $3,000/p/m including per diem
	Travel expenses for consultant	189	10,000	2 trips x US$ 5,000/p/trip
Executive Management Training	Foreign Consultant	883	46,667	US$ 40,000/p/m including per diem
	Travel expenses for consultant	95	5,000	1 trip x US$ 5,000/p/trip
	2-week international study tour			2 x 10 persons
	- travel expense	2,650	140,000	US$ 7,000/p/trip
	- overseas seminars	947	50,000	US$ 25,000/each
Initial training for PMU	***Training facility & equipment***			
	- land:	0	A site is available in Bien Hoa City	
	- office: 300m2 x 2 storeys	7,200	380,308	VND 12 million/m2
	- furniture and fittings	189	10,000	
	- equipment	1,136	60,000	
	3-month study tour:			1 x 4 persons
	- travel expense	644	34,000	US$ 8,500/p/trip
	- overseas training courses	1,893	100,000	US$ 25,000/each
	Foreign Consultant	1,893	100,000	US$ 40,000/p/m including per diem
	Local Consultant	0	0	
	Travel expenses for consultant	379	20,000	4 trips x US$ 5,000/p/trip
Job-related training O&M managers, supervisors and operators	Foreign Consultant	6,626	350,000	US$ 40,000/p/m including per diem
	Local Consultant	994	52,500	US $3,000/p/m including per diem
	Travel expenses for consultant	379	20,000	4 trips x US$ 5,000/p/trip
Job-specific training All O&M staff	Foreign Consultant	2,903	153,333	US$ 40,000/p/m including per diem
	Local Consultant	341	18,000	US $3,000/p/m including per diem
	Travel expenses for consultant	379	20,000	4 trips x US$ 5,000/p/trip
Technical assistance For 1 year after completion	Foreign Consultant	22,718	1,200,000	US$ 40,000/p/m including per diem
	Local Consultant	0	0	
	Travel expenses for consultant	663	35,000	7 trips x $US 5,000/p/trip
	Total	**60,673**	**3,204,808**	
	Total Consultants Foreign Local	45,541 44,206 1,335	2,405,500 2,335,000 70,500	Including travel, per diems and training materials

7.7 Measures to Reduce Operating Costs

Energy Efficiency at the STP

STPs use a large amount of electrical energy. Typically 30% of the operating cost of a treatment plant is budgeted for energy use. In designing the treatment process and selection of equipment, careful considerations should be given to conserve energy and reduce operating costs. An overview of the use of electricity in sewage treatment operation and measures to improve energy efficiency and reduce the cost of operation are presented in this section. In some cases the equipment used to achieve improved energy efficiency requires a larger investment cost or may entail higher maintenance costs e.g. low pressure UV. A detailed cost analysis would be made at the design stage to determine if the savings generated by adopting a certain technology can justify the extra capital cost.

(1) Overview of the Use of Electricity at the STP

The proposed process uses primary treatment (screening and clarification) to remove solids; activated sludge secondary treatment to reduce organic pollutants; and UV disinfection to reduce pathogens. The activated sludge basins are configured to operate with an anoxic zone for biological nitrogen removal if needed.

The operational requirements for sewage collection and treatment systems vary according to the diurnal pattern of the sewage load. The peak energy demand would likely occur from midday to early evening hours, similar to other peak demands in the community. Some plants modify schedules for equipment operation to meet load conditions; others operate system components (such as aeration blowers) continuously at full capacity regardless of the load.

The activated sludge process typically accounts for 30 to 60% of the total plant energy consumption. Advanced treatment for biological removal of nitrogen typically uses 30 to 50 % more electricity for aeration, pumping and solids processing than conventional activated sludge treatment.

Treatment processes and equipment requiring electrical energy are presented in Appendix 8-B with an estimate of annual energy consumption. The distribution of energy at the treatment plant is presented in Table 7.7.1.

Table 7.7.1 Distribution of Energy at the Proposed Treatment Plant

Unit process	kWH/year	% of total
Influent pump station & odor control	1,055,945	12.5%
Primary clarifier and sludge pump	121,910	1.4%
Activated sludge aeration & mixing	5,610,415	66.4%
Secondary clarifiers & RAS/WAS	630,720	7.5%
Thickener & sludge pump	39,055	0.5%
Solids dewatering& odor control	387,685	4.6%
UV disinfection	274,480	3.2%
Process water	77,015	0.9%
Lighting	252,752	3.0%
Total	8,449,977	100%

Most of the electricity is used for:

- Pumping influent sewage flows to the head of the treatment works
- Aeration of the activated sludge
- Pumping systems for the transfer of liquid sludge, biosolids and process water
- Equipment for processing and dewatering biosolids

(2) Measures to Improve Energy Efficiency

With rising energy costs, many sewage treatment plants are turning to advanced technology to operate their systems more efficiently and reduce operating costs. Aeration blowers and pump systems are the largest consumers of energy and prime candidates for energy efficiency measures.

The introduction of new technologies for sewage treatment usually results in a reduction in energy use due to more efficient equipment, but in some cases, such as UV disinfection, they represent the application of more energy intensive processes. The magnitude of potential impacts of new technologies is presented in Table 7.7.2.

Table 7.7.2 Magnitude of Potential Energy Impact of New Technologies

Technology	Energy impact kWh/1000m3
fine pore diffusers (for aeration)	-33 to -40
Ultra-fine pore diffusers	-48 to -58
Dissolved oxygen control systems (compared to manual control)	-13 to -26
Energy efficient blower control systems i.e. guide vanes, inlet butterfly valves, or adjustable-speed drives	-13 to -40
Energy efficient blowers (compared to blowers with inlet guide vanes)	-26 to -40
UV (ultraviolet) disinfection	+13 to +53

Source: Metcalf & Eddy, adopted in part from Burton (1998)

2-1) Fine Pore Diffusers

The equipment used to deliver oxygen to the aeration system is commonly provided by submerged diffused aeration systems. The main components in a diffused air system include a blower(s), air piping system and diffusers that break the air into bubbles as they are dispersed through the aeration tank. The efficiency of oxygen transfer to the sewage depends on several variables; one of the more critical is the type of diffuser used.

STPs often use coarse or medium bubble aerators because they are cheaper, and less likely to foul from impurities in the air flow or from exposure to sewage. Fine bubble aerators are more expensive, require cleaner air, and must be periodically cleaned. However they provide 45% higher oxygen transfer efficiency and even at a higher price, are more cost effective. Studies on retrofits from coarse-bubble systems to fine-bubble systems have produced an average energy savings of approximately 30%, and in some cases up to 50% energy savings using ultra-fine bubble systems. The payback can be 2 to 4 years, factoring in the increased capital cost (for fine bubble diffusers, piping, tankage and gas transfer domes) and the additional maintenance/cleaning cost.

2-2) Automatic Dissolved Oxygen Control

Aeration systems operate to maintain a DO concentration that matches the demand of the biological activity, which is typically around 2.0 mg/l. In manual systems, operators measure the dissolved oxygen level with portable oxygen analyzers and then adjust the aeration system to operate at the desired level. As sewage flow and strength fluctuate constantly, it’s impossible to continuously adjust the aeration system manually to match the DO level. Thus, plant operators using manual systems tend to provide excess oxygen to the ponds/basins to avoid violating the standards, and in doing so operate the blowers more frequently and use more electrical energy than required. With an automatic system to maintain DO at an optimal level, the blowers would not operate continuously or at near full load. Aerator power input is continuously monitored and adjusted to match the actual process oxygen demand, reducing excessive energy use. According to the U.S. Environment Protection Agency (EPA) Design Manual on Fine Pore Aeration Systems, the energy savings achievable by automatic aeration on DO control is typically 25% to 40%, but can be as high as 50%.

2-3) Energy Efficient Blower Control Systems

The most commonly used blowers for aeration systems are positive displacement type blowers and centrifugal blowers (single stage and multi-stage). Typical methods of regulating blower flows are bypassing, inlet throttling, adjustable discharge diffuser, parallel operation of multiple units, timed on/off operation and variable frequency drives (VFD). The method of control depends on the type of blower.

The inlet vanes “throttle” the airflow into a centrifugal blower, thus reducing the amount of airflow through the blower and the power draw of the motor. In the past, discharge throttling had been used as a method to control the blower airflow. Inlet vane throttling is less energy-intensive than discharge throttling. It is not the most efficient, but still it is more efficient than controlling the speed of the blower and the airflow with a VFD.

Positive displacement blowers operate at constant capacity with variable flow and thus cannot be throttled. Their capacity can be controlled through the use of multiple units operating in parallel, timed on/off operation or variable speed drive control.

2-4) Energy-efficient Aeration Blowers

In the past, treatment plants conscious about energy-efficiency had to choose either positive displacement units running on variable speed drives or single stage centrifugal blowers with inlet and outlet vanes. These technologies, while proven, are noisy and energy, and maintenance intensive.

Turbo blowers with air-foil bearings are the newest and most efficient type of blower available on the market today. Turbo blower technology has its roots in the aviation and aerospace industry. This technology relies on an air foil bearing supported on a shaft that is directly integrated with the variable frequency drive, motor and control system in a single enclosure. They operate at high speeds (20,000 to 40,000 rpm) which increases efficiency as a compressor's dynamic efficiency goes up in direct proportion to speed. The air foil bearing eliminates friction between the bearing and the shaft and thus improves the efficiency of the blower while allowing 40% turn down capability for improved control.

Recent studies have shown that turbo blowers can cut energy costs by more than 35%. They take up less space (up to 25% less space than conventional blowers) and are also more quiet, durable and reliable. To date more than 1,500 turbo blowers have been installed worldwide.

2-5) Ultra-violet Disinfection

Many STPs are shifting from chlorine-based disinfection to UV disinfection to eliminate the risk of storage and handling of toxic chemicals. Although UV disinfection is energy intensive, it adds no chemical residue to the effluent. This feature is particularly important when treated sewage is reused or discharged to sensitive aquatic environments.

The main components of a UV disinfection system are mercury arc lamps, a reactor, and ballasts. The source of UV radiation is either low or medium pressure mercury arc lamps with low or high intensities. Medium-pressure lamps are often used in large facilities. They have approximately 15 to 20 times the germicidal UV intensity of low-pressure lamps. Medium pressure high-intensity lamps use considerably more energy than its low-pressure counterparts. However, due to its higher intensity, fewer lamps (though more costly than low-pressure lamps) are required to provide adequate disinfection thereby reducing initial installation costs. Medium pressure high-intensity lamps are typically used for higher sewage flows or on sites where space is limited.

Low-pressure high-intensity lamps provide the same features of low-pressure low-intensity lamps, except that a mercury-indium amalgam is used in place of mercury, which provides greater stability over a broad temperature range and a longer lamp life. Low pressure UV systems are generally 40 to 50% more energy efficient than medium pressure ones. On the other hand, the higher intensity, greater penetration and fewer lamps required with medium pressure UV results in lower capital and maintenance costs. Low pressure UV has been selected for the proposed treatment plant to reduce energy costs.

2-6) Energy Efficient Sludge Thickening and Dewatering

Sludge processing consists of: sludge thickening (primary and secondary sludge are combined), sludge conditioning by polymer addition, mechanical sludge de-watering, and ultimately disposal to landfill.

Thickening increases the solid content of sludge by removing a portion of the liquid prior to dewatering. Gravity thickening, selected for the proposed treatment plant, is the most energy efficient option available.

Belt filter presses and centrifuges are two of the more prevalent dewatering technologies in the sewerage industry. Screw and rotary presses are gaining recognition because of their lower power consumption. Screw presses have been selected for the proposed treatment plant because they can save an estimated 43,680 kWhr/year compared to belt presses.

2-7) Other Potential Energy Saving Measures

Other potential energy saving measures that could be considered at the design stage include:

- Variable frequency drives on influent pumps
- Variable frequency drives on waste and return sludge pumps
- Premium efficiency motors for large continuous duty pumps and blowers
- Capacitors to improve power factor
- Operate emergency generators during peak periods to reduce power demand
- Supervisory control and data acquisition (SCADA) system for monitoring and controlling the demand and energy usage of the plant

2-8) SCADA System

A Supervisory Control and Data Acquisition (SCADA) system is an effective tool for managing the energy usage in a STP. SCADA is a system of sensors, transmitters, controls, communications and computer components used to monitor and control a sewerage system. It can control many of the energy efficiency measures recommended in this report. For example, the SCADA system would use the readings from the dissolved oxygen (DO) sensors to control the amount of aeration, running the aeration equipment only when necessary. If variable frequency drives (VFD) are installed on the aeration equipment, SCADA can also control the speed of the VFD based on the DO readings. Similarly, SCADA can monitor and control other processes and equipment such as pumps, motors, valves, etc. from one location instead of having operators attending individual pieces of equipment at various remote sites.

Some of the benefits of a properly designed SCADA system includes but are not limited to the following:

- Energy cost savings (through continuous process monitoring)
- Reduced operating and maintenance costs
- More precise control of process parameters
- Stabilizes and improves not only operation of controlled process parameters but also processes located downstream
- More accurate data collection (automatic data logging and archiving)
- Better overview of entire system

The more parameters or processes the SCADA is designed to monitor and control, the more effective and efficient the system would be in operating the treatment plant.

7.8 Household Sewerage Connections

The connection of households to the separate sewerage system is the vital link that places the sewerage system into use. Household connections present the most challenging aspect of project implementation and the greatest risk to successful implementation.

Experience with similar sewerage projects in Viet Nam and elsewhere have shown that the chances of success are greatly improved by implementing the following three measures:

- A comprehensive information, education and communication campaign implemented at an early stage in project development. Public awareness of the project and the benefits to be offered is vital to the eventual acceptance and use of the system.
- A funding mechanism to provide an incentive and financial assistance. In Viet Nam the cost of connecting households to the sewer system is generally not included in the project. Sewer connections, when not funded by the investment project represent a significant financial challenge to households. As a result, many sewerage projects have set in place a “sewerage connection revolving fund”, to provide households with financial support to defray most or all of the costs of such connections.
- A provincial decree to make connection of all households mandatory.

This section of the report focuses on these three measures as well as the institutional framework required to support the implementation of house connections. Recommendations are based on:

- Lessons learned in a recent pilot sewerage project in Buon Ma Thuot.
- A recent JICA study on revolving funds for sewerage house connections.
- A willingness-to-pay for a connection survey in the project area carried by the study team.

7.8.1 Previous Studies

(1) Buon Ma Thuot Sewerage Project

The Danida-funded Buon Ma Thuot Sanitation project implemented one of the first separate ewerage systems to be constructed in Viet Nam. It was conceived as a demonstration project to serve as a possible model for future sewerage projects in Viet Nam. Connection of households to a separate sewer system had never before been attempted in Viet Nam. The project initially encountered some delays in getting households to connect but eventually succeeded with a connection ratio over 90%. Thus, the experience gained in Buon Ma Thuot City provides valuable insight for the sewerage project in Bien Hoa.

1-1) Key Points of the Project:

- Approximately 5,500 connections serving 33,000 residents
- Connection to the sewer system was made mandatory by decision of the Provincial People’s Committee (PPC).
- To facilitate household connections, a system of tertiary sewerage pipelines located in the sidewalk areas were constructed on both sides of the street, in front of households to be connected. Multiple connection chambers were provided to reduce costs by shortening the connection distance.
- All residential households were eligible to receive a subsidy of VND1,200,000, estimated to be approximately 50% of the actual cost of a typical household connection. Poor households, registered with the Department of Labor, Invalids and Social Affairs (DOLISA), received a total subsidy of VND2,200,000, equivalent to approximately 90% of the actual cost of a typical household connection. Commercial and institutional connections were not subsidized.
- A House Connection Administrative Unit (HCAU) was created within the PMU to manage house connections. Administration included permitting, technical advice and payment of financial subsidy.
- The project was actively promoted to the community from the early stages of project development. The Information Education and Communication (IEC) component established a multi-media approach which effectively “sold” the advantages of being connected to the system.

1-2) Challenges to the IEC Component

Initially many households appeared to lack the specific motivation to request connection to the system even though they were highly informed regarding the benefits of the Project. These households (HHs) can be categorized into in four groups as follows:

(i) HHs which still had doubts about the benefits of a separate sewerage system.

This group simply required more attention from the IEC staff. Public confidence in the sewerage system increased as more people got connected and this category eventually disappeared.

(ii) HHs that are poor, but non-DOLISA registered, and could not afford to make the household connection even with the subsidy.

This problem was resolved by the selective application of additional subsidy by the HCAU team on a case-by-case basis. Additional financial support to those found to be truly poor provided the necessary encouragement to facilitate connection

(iii) HHs which were newly constructed, with an on-site sanitation system in good condition.

This group required on-going attention by the HCAU staff. These HHs were repeatedly reminded that the requirement to connect to the sewerage system was compulsory, as mandated by the Dak Lak PPC. Penalties were considered to provide enforcement of this mandate.

(iv) HHs which refused to connect without giving any justification for their decision.

This group represented approximately 2-5% of the total number of households. They constituted the most difficult group because they were not interested in listening to IEC promotion. These HHs require on-going attention from HCAU staff and generally required the application of negative reinforcement in the form of a financial penalty to get them to connect to the sewerage system.

1-3) Conclusions

Lessons learned during the implementation of household connection in Buon Ma Thuot that can be applied to the Bien Hoa project include the following:

- Early implementation of IEC promotion would stimulate positive community response
- Institutional framework must decree mandatory connection
- Design the tertiary system with sufficient connection points to make it easy and inexpensive for households to connect
- Government subsidy to poor and low-income households are necessary to create favorable conditions for implementation
- House connection administrative unit must take an active role in promotion to end users

(2) JICA Revolving Fund Study

2-1) Purpose of the Study

JICA has recently (Nov 2010) completed a Revolving Fund (RF) Study for household sewerage connections in Binh Duong and Vinh Phuc provinces where separate sewerage systems are being implemented with JICA funding.

The RF study carried out two important activities that provide useful information for the implementation of household sewerage connections:

- First, household surveys were conducted to assess the willingness to pay for connection to the sewerage system.
- Second, existing revolving fund mechanisms in Viet Nam were reviewed to provide some insight into the design of a revolving fund mechanism for promoting household sewerage connections.

2-2) Willingness to Pay

The average estimated cost of a household connection was approximately 5 million VND in 2010.

The RF study found that willingness-to-pay for a connection ranges from 105,000 VND to 150,000 per month, for a two year repayment period. A significant proportion of households are willing-to-pay an amount sufficient to cover the average cost of a sewerage connection. However, poor and low-income households would need financial support especially if connections are made compulsory.

2-3) Review of Existing Revolving Funds

The RF study reviewed a number of sewerage/sanitation improvement projects in Viet Nam that have used revolving funds. These are presented as projects no.1 to 10 in Table 7.8.1. The study notes two interesting trends in the development of revolving funds:

- “while early revolving funds targeted only the poor and less-poor households, more recent funds have targeted all households, albeit with access to different disbursement mechanisms”.
- “while the disbursement mechanisms of early revolving funds were limited to loans, more recent funds have introduced a two-tier mechanism whereby poor households have access to grants and non-poor households have access to loans”.
- The RF study found that the key issue affecting the design of a potential revolving fund is whether or not connection to the sewerage system would be voluntary or compulsory.
- When connection is voluntary, the main objective of the revolving fund is to provide households with an incentive to connect to the sewerage system. This implies that: (1) most (perhaps all) households should be eligible to receive support; and (2) most of the support would be in the form of grants and not loans.
- When connection is compulsory, the objective of the RF is to provide financial support to poor (and low-income) households to comply with the compulsory requirements. This would imply that: (1) only poor (and low-income) households should be eligible to receive support under the

form of grants; and (2) the type support (grants and loans) would depend on the level of income.

2-4) Recommendations for Future Revolving Funds

Recognizing that recently adopted Decree 88/2007/NC-CP of May 28 2007 explicitly requires compulsory connection to the sewerage system in areas where such systems are available. The RF study makes the following recommendations regarding the design of future revolving funds:

- Who is eligible to receive support from the RF mechanism?
- Following the emerging lessons with sewerage connection revolving funds in Viet Nam, it appears appropriate that all households be eligible to receive support from the revolving fund mechanism. However, different households (categorized by income groups) should have access to different types of support. Commercial, institutional and industrial connections to the sewerage should not receive any form of financial assistance from the RF.
- Which activities can be funded?
- Solely household connection to the sewerage system should be eligible to receive financial support from the RF. Other and better suited forms of financial support are available to poor Vietnamese households for purpose of poverty alleviation. The single key objective of the revolving fund should be to promote and facilitate household connection to the sewerage system.
- How much of the total cost of the sewerage connection can receive funding?
- 100% of the total cost of the sewerage connection should be eligible to receive support from the fund. However, the nature of this funding would different depending on income levels.
- What are the available disbursement mechanisms: Grants or loans or both?
- Poor and low-income households should be eligible to receive grants to cover the total or near total cost of the connections. Non-poor households should have access only to subsidized loans, and not to grants.
- What are the loans conditions (where loans are used)?
- Loans should have a maximum term of no more than 2 years, with a monthly interest rate ranging between 0.65 and 0.9% to reflect changing market conditions.
- Who manages the implementation of the Fund?
- The Women’s Union of Viet Nam has developed a long experience in managing similar funding mechanism and this experience has generally been highly praised.
- Recent experience with sewerage connection revolving funds in Viet Nam indicate that such a fund should have a single objective, which is to support and facilitate sewerage connections. Once this objective has been achieved, the fund should be terminated. The revolving fund should target the bulk of its resources to the poor and low income households by means of grants to cover the costs of the connections.

Table 7.8.1(1) Summary of Existing Revolving Funds for Sewerage and Sanitation Projects in Viet Nam

No.	Project	Location	Eligible activities	Eligible group	Disbursement mechanism	Loan Duration	Interest	Maximum
1	World Bank Three Cities Sanitation Project (1999)	Danang, Haiphong, Halong and Cam Pha	Latrines, septic tanks, and sewer connections	Poor and low-income households	Loans only	No more than 2 years	Pegged to on-going bank interest rate, reviewed annually	90% of capital cost or VND 2 million
2	Asian Development Bank Third Provincial Town Water Supply and Sanitation Project (2001)	Rach Gia, Tay Ninh, Thu Dau Mot, Tuy Hoa, Chi Thanh, La Hai (in Phu Yen province), and Phan Rang (in Ninh Thuan province)	Sanitation facilities, including septic tanks, bathrooms, and connections to drains or sewer	Low-income groups	Grants	none	none	50 to 80 percent of the activity cost depending on the level of incomes of the borrowers
3	Finland Hai Phong Revolving Fund (2001)	3 urban districts of Hai Phong (Ngo Quyen, Le Chan and Hong Bang) and 1 semi-urban district (Hai An);	Latrines, septic tanks, and sewerage connection	Poor and low-income households 8,600 HH	Loans only Funding: 80% Finnish 20% Viet	24 months	0.5% per month in Phase I; 0.65% per month in Phase II Grace period of 4 months	VND 2 millions in Phase I; VND 3 millions in Phase II;
4	DANIDA Buon Ma Thuot Sanitation Project (2001)	Dak Lak Province	Sewer connection	All households	Grants	none	none	Non-poor households: VND1,200,000 (About 50% of the actual cost of a typical household connection). Poor households (DOLISA Registration) VND2,200,000 (About 90% of the actual cost of a typical household connection).
5	Viet Nam Bank for Social Policies (2003)	All of Viet Nam	Safe Water and Rural Environmental Sanitation Program	All households	Loans only	Less than 5 years	About 7.8% per annum	USD 460 No collateral required
6	Australia Three Delta Towns WSS project (2003)	Bac Lieu, Ha Tien, and Sa Dec	Only septic tank systems. Above ground toilets not eligible.	Poor and low-income households	Loans only	No more than 15 months	1% per month	VND 1.5 millions

Source: Project No.1 to 10 JICA Revolving Fund Study on Household Sewerage Connections in Binh Dung and Vinh Phuc, Project No. 11 and 12 JICA Study Team

Table 7.8.1(2) Summary of Existing Revolving Funds for Sewerage and Sanitation Projects in Viet Nam

No.	Project	Location	Eligible activities	Eligible group	Disbursement mechanism	Loan Duration	Interest	Maximum
7	Viet Nam Credit Mechanism for Rural Water Supply and Sanitation (2004)	Rural Viet Nam	To improve water supply and sanitation facilities	Every rural household	Loans only	No more than 5 years	3% 2 years grace period	VND 4.0 millions No more than 80% of construction cost
8	Finland Water and sanitation programme for small towns (2004)	12 small towns	Septic tanks, latrines, and sewerage connections	Poor and low-income households	Loans only	No more than 48 months	0.65% per month	VND 4.0 millions
9	World Bank Red River Delta rural WSS project (2005)	12 provinces of the Red River Delta	To improve water supply and sanitation facilities	Poor and low-income households	Grants and loans	60 months	0.5% per month 6 months grace period	VND 6.0 millions If ‘poor’ households according to MoLISA criteria, 45% of the total amount borrowed is a grant
10	ADB Central Region WSS Project (2010)	Provinces of Binh Dinh, Ha Tinh, Nghe An, Quang Binh, Quang Nam, and Thanh Hoa	Construction of household latrines	Poor and non-poor households	Grants and loans			Maximum grant: 70% of the total latrine investment costs Maximum loan: Latrine total investment costs
11	World Bank Environment and Sanitation Project (2007)	Quy Nhon City, Binh Dinh province	for construction of toilet and household connections to the sewers	991 households	Loan	24 months	0.5% per month 6 months grace period	VND 4.0 millions
12	ADB Environment and Sanitation Project (2005)	Tuy Hoa City and Song Cau town, Phu Yen province	construction of toilet and household sewerage connection	Low-income households	Loan	24 months	0.3% per month	VND 1.5millions

Source: Project No.1 to 10 JICA Revolving Fund Study on Household Sewerage Connections in Binh Dung and Vinh Phuc, Project No. 11 and 12 JICA Study Team

7.8.2 Household Survey for Sewerage Connections in Bien Hoa

The study team carried out a household survey in the proposed project area to assess the willingness-to-pay to connect to the proposed sewerage system. The results of the survey are used to determine the requirements of a potential revolving the fund and the level of subsidy required for households in the priority project I area.

(1) Survey Sample

For purpose of statistical significance, it was determined that a sample of approximately 360 households would be appropriate. The 9 wards in which the project would be constructed have a service population of approximately 29,000 households distributed as shown in Table 7.8.2. Approximately 44% of the population in the project area lives in the existing combined sewer area and it is expected that most of these households would have septic tanks that are connected to the sewer.

Table 7.8.2 Project Ward Characteristics

	Ward	Area (ha)	Population	No. of households	Water consumption m^3/day	Per capita consumption liters/day
Combines sewer area	Thanh Binh	35.28	5,034	1,149	912	181
	Quyet Thang	110.00	15,426	3,128	2,596	168
	Hoa Binh	56.35	7,910	1,749	1,199	152
	Quang Vinh	140.00	15,371	3,292	2,226	145
	Trung Dung	81.98	17,791	3,340	2,525	142
Separate sewer area	Tan Tien	131.34	14,887	2,618	1,718	115
	Thong Nhat	341.00	23,615	4,604	2,528	107
	Tam Hiep	217.69	20,096	5,746	1,935	96
	Tan Mai	136.80	20,986	3,451	1,887	90
Total		1,250.4	141,116	29,077	17,525	
Combined sewer area		34%	44%	12,658	9,457	
Separate sewer area		66%	56%	16,419	8,068	

Source: population and water consumption data from JICA Study team

The Study Team notes a large variation in per capita consumption from ward to ward. This may be a poverty indicator or it may be showing problems in the level of service provided by the water supply system.

In discussions with the PMU it was decided that the sample should be distributed into the wards in proportion to the total project population. It was also decided to take approximately 75% of the households for the survey from the proposed separate sewer area to get a better understanding of the willingness to pay for a new connection. This approach resulted in the sample distribution shown in Table 7.8.3

Table 7.8.3 Number of Households Surveyed in Each Ward

	Ward	No. of households	% of total HH in the project area	No. of poor households	No. of households surveyed if equally distributed	No. of households in the survey
Combines sewer area	Thanh Binh	1,149	4.0%	18	14	8
	Quyet Thang	3,128	10.8%	21	39	22
	Hoa Binh	1,749	6.0%	23	22	12
	Quang Vinh	3,292	11.3%	70	41	23
	Trung Dung	3,340	11.5%	56	41	24
Separate sewer area	Tan Tien	2,618	9.0%	118	32	43
	Thong Nhat	4,604	15.8%	103	57	76
	Tam Hiep	5,746	19.8%	146	71	95
	Tan Mai	3,451	11.9%	37	43	57
Total		29,077	100.0%	592 or 2%	360	360
Total Combined sewer area					157	90 (25%)
Total Separate sewer area					203	270 (75%)

Source: number of households and poverty data from Steering Committee on Poverty Reduction 2009 data.
Official poverty line in 2009 was 650,000 VND per person per month = 3. 3million VND per 5 persons HH.

(2) Survey Template

The study team has adopted more or less the same survey questionnaire template that was used in the JICA RF study for Binh Duong and Vinh Phuc Province. The questionnaire was modified slightly to include some questions on existing septic tank connections and maintenance practices.

Two methods were used to elicit the willingness-to-pay (WTP) in order to increase reliability of the results: the closed-ended and payment card procedures:

- The *close-ended* method was used with half the households. This method presents the household with a specific value (payment) and asks the respondent whether he/she would be willing to pay this value (yes or no being the choice of response). This method is also known as ‘dichotomous choice approach’
- The *stochastic payment* method was used with the other half of the households. This method presents the household with many values (possible payments) and asks the respondent the likelihood that he/she would be willing to pay each of these payments.
- Each questionnaire has three parts (a copy of the survey questionnaires is presented in Appendix 7-A)
- The first part of the survey seeks qualitative information on people’s environmental perception and attitudes. Respondents are asked to indicate the level of agreement with a number of statements about the environment, the current situation of water usage by the household, and their opinion or knowledge of the sewerage and sanitation in the locality.
- The second part of the survey collects information about the households’ WTP to connect to the sewerage system. It is broken down into two sections. The first section describes the system to ensure that respondents understand very clearly the nature of the project and their involvement. A schematic figure showing the proposed house connection is provided to the respondent to facilitate comprehension. Before asking questions pertaining precisely to the WTP, respondents are given the opportunity to ask questions about the technical features of the

project. The second section includes the questions on WTP using one of two elicitation methods: closed ended question or stochastic payment card.

- The third part of the survey collects information about the socio-economic characteristics of the respondents. These included age, gender, education, household size, income, expenditure, assets and the trend of changes in income in recent years. These characteristics are correlated to the WTP answers.

(3) Sampling Strategy

Half the households (180 in total) were given a questionnaire with the stochastic payment card. The other half received a questionnaire with a close-ended question.

For the close-ended version, respondents were asked if they would vote (Yes or No) in favor of the action plan with one of three bid levels of VND 100,000, 150,000 or 200,000. Each questionnaire contains only 1 bid value and these were randomly distributed to surveyors: 60 respondents were presented with a bid VND 100,0000, 60 with a bid of VND150,000, and 60 with a bid of VND 200,000.

The distribution of questionnaires throughout the sample was completely random and is shown diagrammatically in Figure 7.8.1

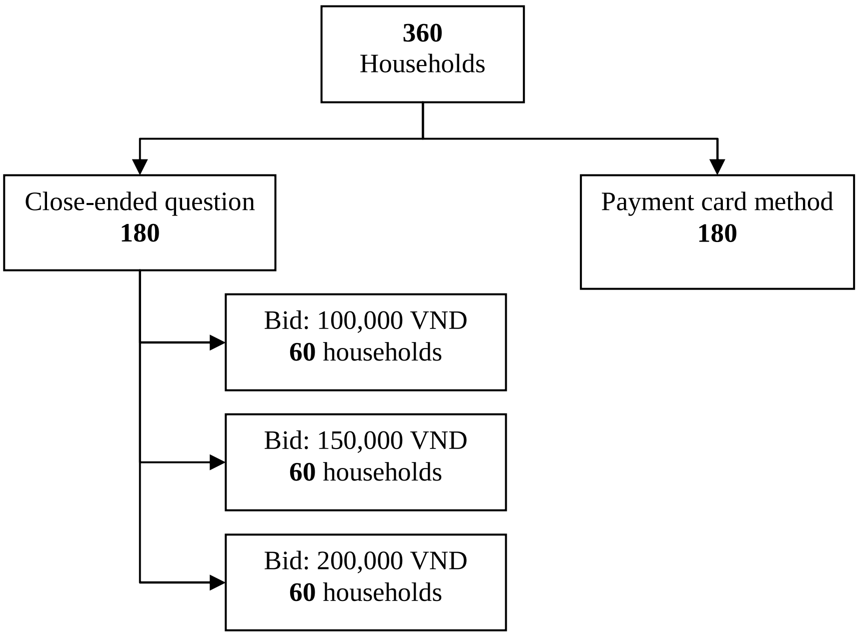


Figure 7.8.1 Distribution of WTP According to Elicitation Method

(4) Pre-test

A draft of the survey questionnaire was pre-tested with 6 households to ensure that the questions and scenarios were understood by the respondents and the surveyors. The issues to be examined in the course of the pre-testing included: (i) whether there was any lack of clarity or misunderstandings of the questions presented to the respondents; (ii) whether the alternatives presented to the respondents were appropriate; (iii) whether there was a large number of unanswered questions; and (iv) whether the range of payments presented to the respondents was appropriate. In general, the respondents did not find it difficult to answer the questionnaire. The questionnaire was revised and finalized to address the concerns raised by the respondents in the course of the pre-test. It was also an opportunity for the survey team to gain experience working with households, and to find the best strategy of approaching the respondents and asking questions.

(5) Survey Implementation

The survey was implemented by means of direct household interviews, conducted by enumerators trained to approach the respondents and ask the WTP questions to ensure the reliability of the answers.

Target clusters of households were identified in each ward by drawing circles at random on a map. The survey team selected a number of households at random within each one of these clusters.

The survey was conducted from 24 Dec 2010 to 21 Jan 2011. Most of the interviews took place during the weekend or in the evening (16:00 to 20:00) to ensure the presence of key household members at the time of the survey. If and when a selected household refused to participate in the survey (following the request for explicit consent to participate presented by the enumerator), the adjacent neighboring household was selected.

The survey team was accompanied by the leader of the local commune and staff of the Womens Union to facilitate access to the households. However, interviews were conducted without their presence for the purpose of eliminating a possible bias which might be caused by the presence of an outsider.

(6) Survey Results

Survey questionnaire and results of the household survey are outlined in a separate report. Key findings are summarized in the following subsections.

6-1) Willingness to Pay

The mean WTP for a new connection is 114,600 VND per month over a 24 month period. This represents a total cost of 2.75 million VND which is considerably less than the estimated cost of making a connection. (9.7 million VND)

6-2) Socio-economic Characteristics

The average number of persons per household is 5 and the average number of income earners per household is about 3.

The poverty line is VND 850,000 per person per month as defined in Decision No. 176/2010/NQ-HĐND dated on July 02, 2010 issued by DNPPC. This is equivalent to 4.3 million VND per month for an average household of 5.

About 18 % of households surveyed reported a household income below the official poverty line. Another 12% of households are close to poverty with monthly income less than 5 million VND which indicates that nearly 30% of households surveyed can be classified as poor.

The percentage of poor households appears to be too high when compared to the "official" value of 2% estimated and reported by the Committee on Poverty Reduction. The results of the household survey are probably biased because it is not unusual for respondents in this type of survey to under report their actual income. The Study Team estimates that the actual number of poor households is probably around 10% (higher than the officially reported number but lower than the survey results).

About 49% of households surveyed had an income above poverty line but below 10 million VND per month.

About 40% of households spend less than 4 million VND per month (poverty line income). Another 39% spends between 4 and 6 million VND per month.

6-3) Septic Tanks

The survey indicates that most households (over 95%) have septic tanks connected to the sewer system. About 19% of households have septic tanks that are connected to a soak away pit only with no connection to the sewer. The results are similar for households living in the existing combined sewer area and those living in the proposed separate sewer area where sewage is discharged to open channel drains. A very high percentage of households indicated that they want to connect to the new sewer system and abandon their septic tanks.

Table 7.8.4 Survey Results on Septic Tank and Its Connection

Item	Combined sewer area	Proposed separate sewer area
HH with Septic tanks	98%	96.1%
Septic tanks connection		
- Public	73.5%	69.9%
- Soak away pit	19.3%	19.8%
- Garden	7.1%	10.3%
Willing to abandon septic tanks to connect to the sewer	85.7%	96.1%

6-4) Awareness of the Project and Environmental Issues

The survey indicates that people are generally aware of environmental issues but few have heard about the proposed sewerage project:

- 87% indicated that they are aware that their sewage is untreated
- 97% indicated that they believed untreated sewage was polluting streams and the river
- 99% indicated that cleaning the environment was important to them
- Water Pollution was ranked as the second most important priority for Dong Nai (27.5% of respondents). Health care was the first priority (32.5% of respondents).
- 84.5% of the households surveyed have never heard of the proposed sewerage project.

The proposed Information, Education and Communication campaign must focus on informing residents about the details and the benefits of the proposed project as well as promote connection to the sewer system.

7.8.3 Financial Arrangements to Promote House Connections

The Study Team estimates that the average cost of a household connection in April, 2011 is approximately 9,666,720 VND. The household survey indicates that most households are only WTP 114,600 VND per month for a 2 year repayment period. This is equivalent to a total cost of 2.75 million VND and is not sufficient to cover the estimated average cost of a sewer connection. Therefore most households would require substantial financial assistance to make the project viable.

Based on a review of other projects in Viet Nam the Study Team proposes that two types of funding programs be implemented to provide financial assistance to households in the project area: i) grants and ii) loans at attractive rates.

Every household would be eligible for a grant. Poor households would be eligible for a 100% grant. Non-poor households would also be eligible to receive a grant but only to cover a portion of the cost.

A Revolving Loan Fund (RLF) would be set up to provide non-poor households with access to capital to they might not otherwise be able to get and to reduce borrowing costs.

The grant portion for non-poor households must be sufficiently high to make the monthly loan repayments relatively close to the WTP amount identified by the survey. The Study Team has carried out a financial analysis to estimate the following key specifications of the Grant and Revolving Loan Fund for the proposed project:

- Percentage of the cost covered by grant for non-poor households
- Monthly loan repayment amount and its comparison with WTP
- Required seed fund for the Grant Fund and Revolving Fund

Four different scenarios were analyzed to compare a borrower's monthly repayment amount to the WTP amount: (i) Baseline case with 50% grant, (ii) 60% grant, (iii) 70% grant and iv) 80% grant. The seed fund amount is calculated for each case.

(1) Assumptions for Revolving Fund Analysis

The revolving fund analysis makes the following key assumptions:

Cost of the connection:

- Price escalation, physical contingency and VAT are applied to the base cost following the methods used to estimate project costs presented in section 7.9.
- The unit cost of a house connection would increase more than 2.4 times between now and the end of the project because of the high inflation rate of local currency (See Table 7.8.5).

Table 7.8.5 House Connection Unit Cost

Construction Year	2011 Base Cost	2016	2017	2018	2019	2020
Base Cost	**8,768,000**	**8,768,000**	**8,768,000**	**8,768,000**	**8,768,000**	**8,768,000**
Price Escalation	-	5,676,813	7,193,519	8,869,478	10,721,413	12,767,802
Physical Contingency	438,400	722,241	798,076	881,874	974,471	1,076,790
VAT	460,320	758,353	837,980	925,968	1,023,194	1,130,630
Total	**9,666,720**	**15,925,407**	**17,597,574**	**19,445,320**	**21,487,078**	**23,743,221**

Source: JICA Study Team, price escalation taken as 10.5%p.a. on local currency

Number of connections:

- According to the implementation program, 28,700 house connections would be constructed over 60 months from 2016 to 2020. It is assumed that the number of connections constructed in a month would be equally distributed over the period.
- 2,870 households (10%) are categorized as poor

Grants

- Poor households would receive 100% subsidy in the form of a grant
- Non-poor households would receive 70% subsidy in the form of a grant

Loan terms are the same as those recommended in the JICA Revolving Fund Study:

- (i) interest rate of 0.9% per month or 10.8% p.a.;
- (ii) repayment period of 24 months; and
- (iii) repayment based on equal monthly installments.
- The maximum loan amount would be 3 million VND based on WTP (24 × 114,600 =

2.75 million rounded up)

Operation of the fund:

- Administration expense is excluded from the analysis but should be added to the annual disbursement of funds. A typical amount is 10% of the total funds disbursed.
- Non-performing loans (arrears or non-repayments from borrowers) is 10% of total loans.

(2) Revolving Fund Analysis

Table 7.8.6 presents a summary of the results of the financial projection for each grant scenario.

Table 7.8.6 Revolving Loan Fund Financial Projections

Item	Unit	Case 1	Case 2	Case 3	Case 4
Grant Portion for Poor HHs		100%	100%	100%	100%
Grant Portion for Non-poor HHs	-	50%	60%	70%	80%
Loan Portion for Non-poor HHs	-	50%	40%	30%	20%
Monthly Repayment Amount per HH	2016 Price VND	333,347	266,678	200,008	133,339
Monthly Repayment Amount per HH*	2011 Base Price VND	**202,342**	**161,873**	**121,405**	**80,937**
Seed Fund Requirement	VND million	366,524	405,951	445,378	484,806
Rounded	VND million	**367,000**	**406,000**	**446,000**	**485,000**
Grants	VND million	235,056	273,519	311,983	350,447
Revolving Loan Fund	VND million	131,944	132,481	134,017	134,553

Source: JICA Study Team, Note: excluding administrative costs

The Study Team recommends a 70% grant for non-poor households to make the monthly loan repayment amount close to the WTP amount. The total amount of funding required would be 446,000 million VND or $US23.6 million. This works out to an average of $US820 per house connection which is considered reasonable.

Fund disbursements projected over the construction period would total VND 564 billion as shown in Table 7.8.7.

Table 7.8.7 Fund Disbursements

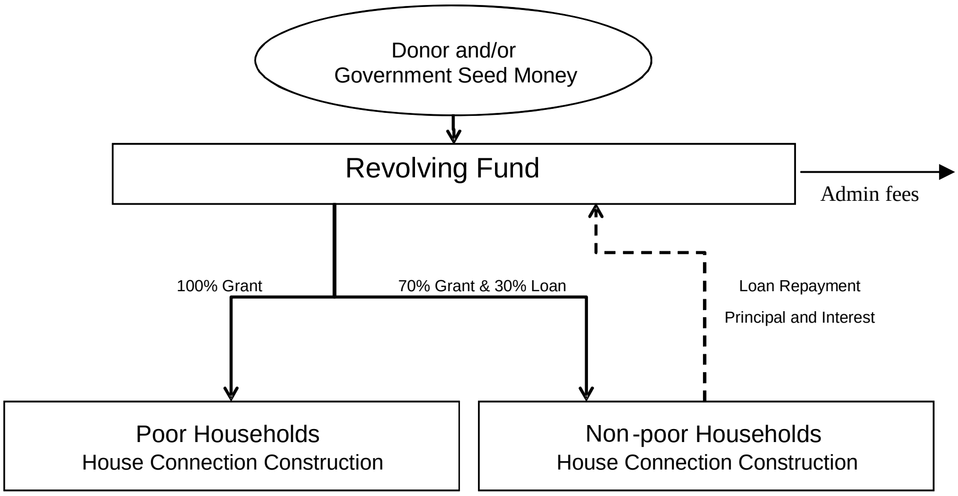
Construction Year	Unit	2016	2017	2018	2019	2020	TOTAL
No. of Connections	Connections	**5,740**	**5,740**	**5,740**	**5,740**	**5,740**	**28,700**
Poor Households	Connections	574	574	574	574	574	2,870
Non-poor Households	Connections	5,166	5,166	5,166	5,166	5,166	25,830
Grant 100% to Poor HHs	VND million	9,141	10,101	11,162	12,334	13,629	56,366
70% Grant for Non-poor HHs	VND million	57,589	63,636	70,318	77,702	85,860	355,106
30% loan for Non-poor HHs	VND million	24,681	27,273	30,136	33,301	36,797	152,188
Total Disbursements	VND million	**91,412**	**101,010**	**111,616**	**123,336**	**136,286**	**563,660**

Source: JICA Study Team, Note: based on price escalated unit cost of connection

(3) Operation of the Revolving Fund

The fund would be managed by the PMU and administered by the Women’s Union. The Study Team suggests that seed money can be allocated from the PPC budget or from proceeds of the

JICA loan or both. Figure 7.8.2 shows the basic fund flows. The loan repayments from households would be used to fund the next disbursement requirements. After the completion of the revolving fund operation (repayment period), the balance of funds could be used for sewer connections in other parts of the City and/or for repayments of the JICA ODA loan in case that the ODA loan finances the seed money for the fund.



Source: JICA Study Team

Figure 7.8.2 Revolving Fund Operation

7.8.4 Creating the Proper Institutional Framework for Household Connections

Household connections present the most challenging aspect of Project implementation and the identification of this challenge (and risk) at the earliest stage in Project development is the important and necessary first step on the road to successful implementation.

The PMU must work closely with the DNPPC to establish appropriate governmental policies for facilitating the implementation of household connections bureaucratic and legal procedures must be fully established before the implementation of house connections.

There are three key elements (decisions) that must be put in place by the PPC to facilitate the house connection process:

i. *Mandatory Sewerage Connection of All Households*: All households which are located within the designated piped sewerage service area shall be connected to the system. This is in accordance with Decree 88 Article 41 however exemptions stipulated in the decree should not be allowed.

ii. *Standards for household connection*: The construction of the sewerage connection shall be the direct responsibility of each household, with the choice of either fully contracting this work to a qualified contractor of their choice or by constructing all or part of the work with their own labor. The scope of the household connection works must be clearly defined by a technical brochure disseminated to the community with additional assistance available through the PMU's public relations staff.

iii. *Financial Subsidy for Household Connections***:** The cost of making a connection would be subsidized by grants: poor households 100% and non-poor 70%. A revolving loan fund would be set up to assist non-poor households with paying for the balance of the costs. Grant and loan amounts should be based on the actual cost of a typical household connection at the time to project is implemented. Commercial and institutional connections shall not be subsidized.

The process of getting householders to connections must be administered and monitored closely by the PMU since this is the vital link that would lead to a successful project. Administration shall include:

1) Setting the requirements for borrowers.
   a. Eligibility
   b. Reporting
   c. Insurance or collateral
2) Setting loan terms.
   a. Maximum length
   b. Maximum and minimum loan amounts
   c. Administrative fees
   d. interest rates
   e. Repayment
   f. Default and delinquency
3) Developing forms for the program.
   a. Loan application
   b. Loan disbursement
   c. Reporting
4) Providing grants, loans and technical assistance to borrowers
5) Tracking and monitoring existing loans. Tracking and monitoring progress towards program goals. Offering technical assistance to borrowers and communicating success of program.

The Study Team recommends that a House Connection Administration Unit (HCAU), operating under the PMU, be created to administer the household connection program. The HCAU would also play an active role in promoting house connections to end users by providing technical support to the public relations unit.

A purpose designed building should be constructed or rented to facilitate the public interaction foreseen to administer this work. The building should be equipped with a networked computer system installed with custom-designed database software, to facilitate efficient administration of the works and data basing of the collected information. Most importantly, the staff of the HCAU should receive extensive specific training in the areas of customer service, in the use of the specialized computer software and with regard to knowledge of the technical aspects of constructing the household connection.

7.9 Information Education and Communication (IEC) Campaign

(1) Introduction

The sewerage project aims to reduce water pollution and ultimately improve the health and quality of life of people in Bien Hoa City. These goals can only be achieved if all or most of the households in the area are eventually connected to the new separate sewerage system. Without household connections, the system serves no purpose and the investment is wasted.

The public must know about the project and appreciate the benefits before they would accept and use the system. Unfortunately their level of environmental awareness and knowledge of sewerage as well as willingness to connect and pay for services at present is limited. Experience with the sewerage projects in other cities in Viet Nam has shown that early planning to promote household connection is essential for acceptance and participation. Therefore, the Study Team recommends that the project be publicized to the community as early as possible by means of an information, education and communication (IEC) campaign.

The IEC campaign would stimulate a positive community response and secure public support for the project by:

- Providing detailed information about the project activities and their beneficial outcomes.
- Educating people on the negative impacts of solid waste disposal to drains and gutters.
- Educating people on water environment issues and the need for their participation on sewage management.
- Encouraging people in residential areas to connect to sewer system,
- This section of the report describes the concept of an IEC campaign and derives a cost estimate for execution. The implementation strategy would be developed at future stages of the project and are not covered in this study.

The IEC campaign would run parallel to the implementation of the sewerage project, in close cooperation and with the support of the Project’s technical design and institutional development components.

(2) Communications Planning

A successful IEC campaign relies on a sound communications plan. Guidelines on the management and implementation of communication activities for sewerage projects in Viet Nam have been published by GTZ (June 2010 Wastewater and Solid Waste Management in Provincial

Centers). This guideline document has been translated into Vietnamese and provides an overview of communications concepts and the principals for implementing IEC campaigns.

Communication plans may differ depending on the type of project. Nevertheless, the general approach adopted by many communications experts all over the world has the following principal steps:

- State Objectives
- Identify Stakeholders/actors
- Design Strategy
- Identify Target groups
- Formulate Key messages
- Identify and set up Communication Channels/ implement activities
- Assess outcome
- Adjust strategy and implementation

(3) Stakeholders/actors

The IEC campaign would require information and support of various outside organizations and stakeholders. Campaign activities would be coordinated with activities carried out by the administrative representatives of the CPC at Commune and Ward levels, the Health Sector, the Education Sector, the Information Sector, and various socio-political organizations such as the Youth Union and the Women's Union. Outside organizations and stakeholders identified at this stage are:

- PMU (Public Communication Officer and Sanitation Trainers)
- Provincial People's Committee
- City's People Committee operational staff at local level
- Department of Natural Resources and Environment (DONRE)
- Department of Health (DOH)
- Department of Education and Training (DOET)
- Socio-political organizations: Youth Union and the Women's Union
- Provincial and city mass media

(4) Community Target Groups

The target groups for the IEC campaign include the following segments of the community:

- Households represent the biggest target segment. Household heads would learn all the details about the project and the principles of sewage management.

- Business establishments – owners or managers of business establishments that produce sewage such as factories, large food chains, private hospitals and other private service establishments, are in this target segment. Information on water pollution, sewage treatment and regulations would be most relevant and useful to this target group.
- Government institutions – administrators or managers of government hospitals, schools, and other public establishments that produce sewage are also targets of the campaign. They would receive the same information as the business establishments.
- Operational staff of the People's Committees at Districts, Communes, Wards, Villages and Household Clusters levels; Information about the project and the principles of waste water management and regulations would be most relevant to this target group
- Operational staff of socio-political organizations: mainly Women Union and Youth Union. They would receive the same information as households.

(5) Key Messages

The IEC campaign would establish a multi-media approach to encourage the use of the piped sewerage system in the community. This would involve the promotion of the advantages of being connected to the system, such as no more worries about operating and maintaining septic tanks/soak away pits, the safe and hygienic disposal of the household's sewage and the importance of being an environmentally conscious citizen.

The campaign would also provide general information on the sewerage infrastructure and the procedures and methods used to connect households to the system.

The following basic principles and practices of sewage management at the community level need to be properly communicated to the target audience:

- Water in the Dong Nai River is a resource that must be protected because it is used by other communities downstream. Untreated sewage from Bien Hoa would contaminate the river.
- Owning a septic tank is not enough to protect the water environment. It provides only primary treatment of sewage by removing solids. The effluent from septic tanks must be collected by a sewer system and further treated before being discharged to the environment
- Connecting to the sewer system would eliminate the need to have a septic tank and hence the problems and costs of maintaining one.
- Sewage is treated using a biological process which would not function if there is excessive amounts of household chemicals and solid waste. Therefore water used for cleaning latex paint brushes and cans, coffee grounds, cooking fats/grease, paper towels, disposable diapers, sanitary napkins, cigarette butts, and other non-decomposable materials should not be disposed to sewers.

- Open drains and curbside gutters are meant to collect rainwater. Garbage disposal to the drains is a source of contamination, causes odors and blockage which leads to flooding and poor drainage of roads. It is also very costly for URENCO to remove garbage from drains and sewers.

(6) Communication Channels

Information to the public would be diffused using one-way communication tools as well as instruments of interpersonal communication. The method of choice would be tailored for each target group to obtain the optimal response. The sewerage project in Buon Ma Thuot City found that mass dissemination of a brochure to the residents of the sewerage service area was the most effective way to communicate with future customers, as well as motivate the residents to connect to the sewerage system. Interpersonal communication would also play an important role since previous awareness raising experiences in Viet Nam show that they worked quite well at mobilizing communities.

(7) Activities and Approach

The following pre-campaign activities would be required to understand what to communicate and how best to do so:

- Carrying out a community knowledge, attitude and practices (KAP) assessment,
- Conducting interviews/focused discussion groups (FGD) and survey of representative community groups to understand the general perceptions and attitudes on water environment, sewerage, connection charges and sewerage tariffs.
- Capacity building and training for PMU communications team and other stakeholders involved in implementing the IEC campaign.
- Assessing media options (TV, radio, cinema, print, community meetings, posters, school programs, cultural event, local newspaper, cable operators, etc.).
- Identifying the primary impediments/constraints to connecting to the sewerage system and an adjustment in tariff structure as required.
- The IEC campaign strategy and materials would then be developed according to the needs of the target audience and the challenges the campaign has to overcome. The IEC consultant would undertake the following in preparation for the launch of the campaign:
- Develop the IEC campaign plan and related materials.
- Develop a strategy, the key messages & timeline for their delivery.
- Prepare IEC materials for each phase of the campaign.
- Brief local stakeholders on the implementation of the IEC campaign.

The process of communicating key messages to the target groups would include the following:

- Short radio and television broadcasts to provide regular status updates about the project to the community to gain their support.
- Community group meetings where short presentations would be made and quarterly newsletters and brochures would be distributed to promote the project
- Stakeholder seminars organized at frequent intervals to learn about the issues they face and to work with them to find solutions.
- Schools program for various age groups to deliver lectures and conduct debates and discussions on the water environment and the on-going project.
- Information to residents during construction to announce road closures and disruption in services.
- The IEC materials (TV spot; TV drama; radio serials; flip chart, poster, brochure etc.) would be pre-tested to determine their suitability and effectiveness and subsequently revised as required. The target audiences would be surveyed to monitor the change in perception as a result of the campaign and over the course of the project.

(8) Monitoring and Evaluation

The IEC activities and materials may need to be adjusted as the campaign unfolds. A monitoring and evaluation (M&E) framework would provide feedback to the responsible entities and identify problems to allow timely corrective actions. The M&E activities would also determine if the ultimate goal of community acceptance and willingness to connect to the system is being achieved.

Monitoring and evaluation would be carried out in three ways:

- regular monitoring using performance indicators;
- interim external audit after 3 years;
- external impact assessment survey at the end of the IEC campaign.

Baseline conditions would be taken from the household survey carried out in January 2011 and the KAP survey carried out as part of the IEC campaign.

(9) Institutional Set-up

The PMU would be responsible for the IEC campaign. The study team proposes that a new Public Relations Unit (PRU) be created within the PMU to manage and deliver the IEC campaign. After project implementation, the PRU would become part of the customer care unit at the new Sewerage and Drainage Company to handle on-going public relations. Alternatively the PRU could remain with the PMU to manage IEC campaigns for other sewerage development projects.

The PRU would be made up of the following staffing complement for the first phase of the sewerage project:

- Public communications officer (1)
- Sanitation trainers (4)
- Motivators (18)

Public Communications Officer

The Public Communications Officer (PCO) would manage all IEC activities and staff in the PRU.

Sanitation Trainers

Sanitation Trainers would work full time with the households affected by the project. They would be recruited from various socio-political organizations with experience in awareness raising and encouraging community participation, i.e. members of the Women Union, the Youth Union, and the Farmers' Union. The 4 members (2 men and 2 women) would function in two 2-person teams.

Motivators

These persons from the city's socio-political organizations would work part time to reinforce key messages in their respective wards, to complement the efforts of the Sanitation Trainers. Specific Memorandum of Understandings would be signed between the PMU and the participating socio-political organizations. Eighteen Motivators would be required to work in teams of two in each of the 9 wards affected by the project.

(10) IEC Consultancy

The IEC campaign is a large and complex undertaking. An international consultant with experience in designing IEC campaigns for sewerage would be required to assist the PMU. In addition to planning and designing the IEC campaign, the consultant would also help with capacity building for the PMU communications team and representatives of external agencies that would be involved in delivering the IEC material. The consultant could also be involved in delivering the IEC as well as the monitoring and evaluation tasks.

(11) Implementation Schedule and Costs

Sewage management is a complex subject involving many concepts and practices that are neither easy to explain nor to understand. They must be introduced in a stepwise fashion, always ensuring sound appreciation of a topic before proceeding to the next one. Also some practices cannot be promoted until certain elements are in place. For instance, connection to the sewer system can only take place after the downstream collection system including tertiary pipes have been completed and the operation handed over to the responsible authority.

Experience with The Danida-funded Buon Ma Thuot sewerage project has shown that the IEC campaign should start well before construction. When the project and its impacts are better known and understood, it becomes easier to convince the communities of the benefits of connecting to the sewerage system, to secure their willingness to pay for connecting to the sewerage system, to accept the increase of the sewage tariff, and to adopt behaviours that would ensure proper operation and maintenance of the drainage/sewerage system.

The IEC campaign should begin no later than 6 months before the start of construction and continue through the construction period (72 months).

The IEC would be carried out in phases, starting with the awareness and knowledge generating phase within the first 6 months of the campaign; and the promotion of house connections and desired practices from Years two to six during construction. Continuing education would be conducted at regular intervals during and post- construction. This would ensure the participation of residents in the O&M of the drainage/sewerage network, through their good civic behaviour regarding discharge of sewage, maintenance of their septic tanks and disposal of solid waste.

The IEC campaign would be delivered in three phases over a period of 72 months.

11-1) *Phase 1 – Information and Awareness Raising Phase*

This phase would last 6 months and would be completed before construction. This first phase would generate heightened awareness for the project and deal with the concerns of the target groups. It would consist of frequent broadcasts of simple, easy to grasp messages or slogans, through various media outlets. The information would require no lengthy explanation, but would prepare the public for what would follow.

11-2) *Phase 2 – Educational & Information Phase*

This phase would start when construction begins and last 18 months. This second phase would deepen the knowledge and appreciation of the target groups regarding sewage management practices and the sewerage project. Information and educational sessions would be delivered along side the on-going media campaign. Residents would be kept informed of on-going construction activities, road closures and disruption of services. Having been exposed to Phase 1, the target groups would be aware of the issues and would want to know more. The public would learn how sewage would be treated and why all sources of sewage from the house should be collected including bath and kitchen wastewater.

11-3) *Phase 3 – Information, Continuing Education and Action Promotion Phase*

This phase would start after phase 2 and continue for 48 months, finishing at the end of the construction contract for household connections. It is essential to maintain a high level of awareness in the target groups, as attention on the issues invariably diminishes over time. Residents would continue to be informed about construction activities. Continuing education would serve as a reminder and emphasize the promotion of household connections to ultimately secure full participation. Calls to action would dominate this phase, accompanied by aggressive mobilization and promotional activities to trigger actual connections to the sewer system. The public should understand how the sewer connection would be made, how it affects the plumbing in their house and the costs of connecting to the sewer system. An explanation of the revolving fund would be provided during this phase of the campaign.

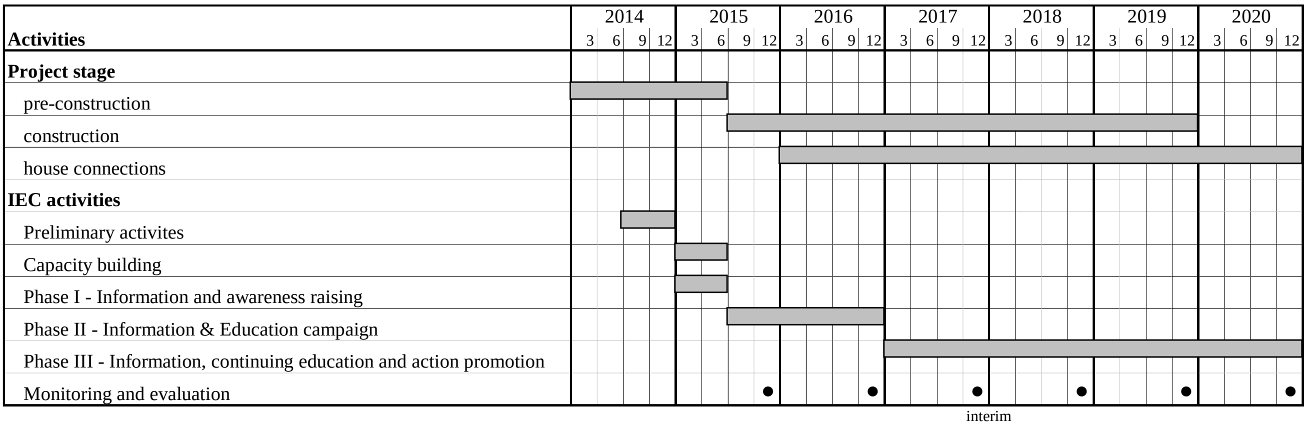


Figure 7.9.1 Outline Program for Information Education Communication Campaign

Table 7.9.2 Outline Costs for Information Education Communication Campaign

Activities	Items	Estimated consultant person-months		Consultant Costs		Facilitation costs	Total costs ($US)
		Foreign	Local	Foreign	Local	LS	
Preliminary activities	Carry out knowledge, attitude and practices (KAP) assessment	2	8	80,000	24,000	5,000	109,000
	Conducting interviews/ focused discussion groups (FGD)	-	2	-	6,000	3,500	9,500
	Assess media options	1	2	40,000	6,000	-	46,000
	Identifying constraints to connecting to the sewerage system	-	2	-	6,000	-	6,000
	Prepare IEC materials and strategy	4	6	160,000	18,000		178,000
Public relations training	Training staff in the public relations unit	4	1	160,000	3,000	-	163,000
	computers and audio visual equipment	-	1	-	3,000	20,000	23,000
IEC activities	**Phase I - Information and awareness raising (6 months)**						
	News media campaigns	1	2	40,000	6,000	15,000	61,000
	Community group meetings	1	4	40,000	12,000	10,000	62,000
	Stakeholder seminars	1	2	40,000	6,000	5,000	51,000
	Phase II - Information, Education campaign (18 months)						
	News media campaigns	3	3	120,000	9,000	20,000	149,000
	Community group meetings	2	6	80,000	18,000	10,000	108,000
	Stakeholder seminars	-	3	-	9,000	5,000	14,000
	Schools programs	1	6	40,000	18,000	15,000	73,000
	Information to residents during construction	-	6	-	18,000		18,000
	Phase III - Information,continuing education and action promotion (48 months)						
	News media campaigns	4	8	160,000	24,000	20,000	204,000
	Community group meetings	2	8	80,000	24,000	10,000	114,000
	Stakeholder seminars	-	4	-	12,000		12,000
	Schools programs	2	6	80,000	18,000	3,500	101,500
	Information to residents during construction	-	8	-	24,000	9,000	33,000
Monitoring and evaluation	Annual surveys and evaluation against performance indicators	-	8	-	24,000	5,000	29,000
	Interim external audit after phase II	-	3	-	9,000		9,000
	External impact assessment at the end of phase III	-	3	-	9,000		9,000
Total		28	102	1,120,000	306,000	156,000	1,582,000

CHAPTER 8 IMPLEMENTATION PROGRAM, COST ESTIMATE, AND PROCUREMENT

8.1 Implementation Program

Priority Project I comprises three components: A. Construction and Equipment Purchase B. Engineering Services, and C. Preparations by project owner. These components and their related activities are summarized bellow.

A. Construction and Equipment Purchase

A1: Site Work for STP2

A2: Sewerage and drainage system construction

1) Separate sewers
2) Interceptor sewers
3) Overflow chambers with flap gates
4) Main pumping station (PS1) and manhole type pumping stations
5) STP2 (including PS5)
6) Storm water sewer construction

A3: Canal improvements

A4: Maintenance equipment purchase

B. Engineering Services

B1: Detailed design (D/D, including surveys), tender assistance and supervision (SV)

B2: Capacity building (C/B)

B3: Information Education and Communication (IEC) Campaign

C. Preparatory Works by project owner

C1: Land acquisition for STP2, PS1 and canal improvements

C2: Establishment of a new company (SDCO)

C3: Tariff setting

The proposed schedule for the above activities is presented in Figure 8.1.1 and 8.1.2. The schedule is based on the following timeframes for completion:

(1) Selection of consultants	: 7 Months
(2) Detailed Design including surveys	: 18 Months
(3) Tender Assistance for Local Competitive Bidding (LCB)	: 3 Months

(4) Tender Assistance for International Competitive Bidding (ICB) : 14 Months

- Preparation of tender document and JICA concurrence : 3 Months
- Tender period : 3 Months
- Evaluation of bids : 1 Month
- JICA concurrence of bid evaluation : 1 Months
- Contract negotiation : 4 Months
- JICA concurrence of contract : 1 Month
- Opening of credit and issuance of letter of commitment : 1 Month

Other sewerage projects must be implemented after Priority Project I to continue to improve the environment and sanitary conditions in the city. A study (F/S) is proposed near the end of the construction period to determine the feasibility and scope of a second project.

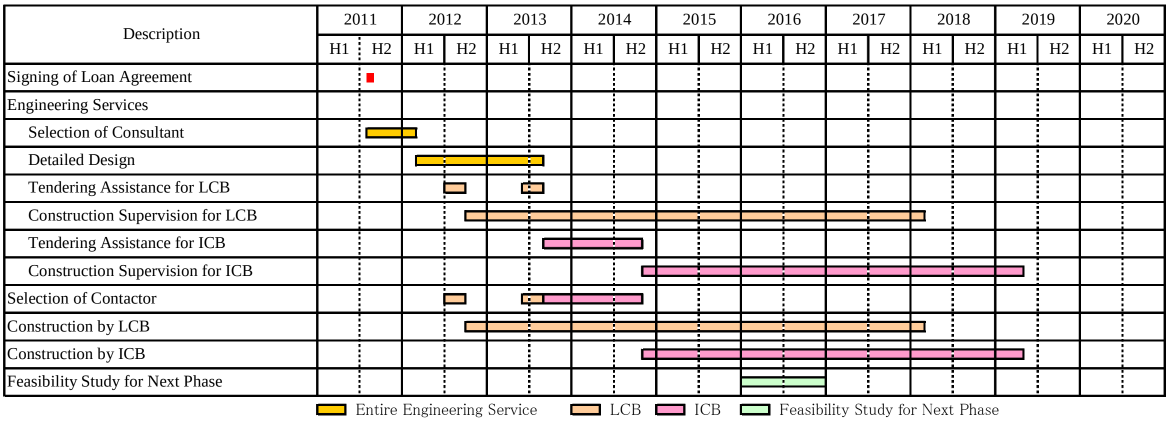


Figure 8.1.1 Implementation Schedule for Construction

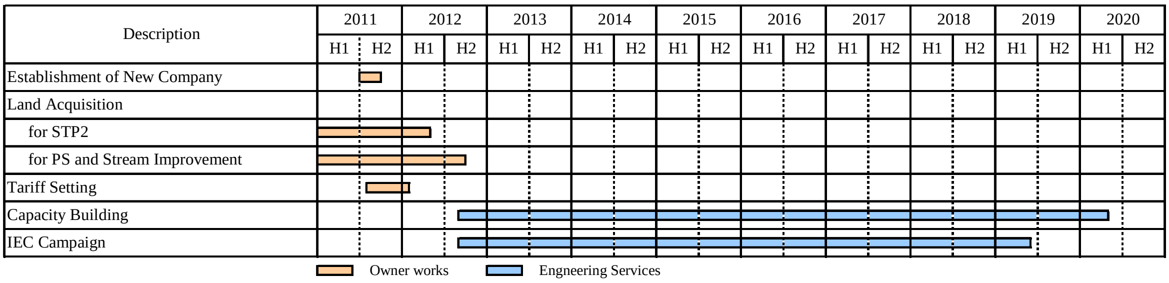


Figure 8.1.2 Implementation Schedule for Preparatory Works

8.2 Engineering Services

The Project Management Unit (PMU) would implement the design and construction of the project. To ensure the sustainable and effective operation of drainage and sewerage systems it is crucial for the PPC, CPC and PMU to create a new organization to manage the system as well as set a proper tariff for the services. Operating personnel must be well trained to identify and deal with operational problems, carry out preventive maintenance and perform laboratory analysis to monitor the process and the effluent for compliance with environmental regulations.

A plan is required to recruit and train staff for management, operation and maintenance, public relations, administration and financial functions. Public cooperation at various levels is essential for effective operation of the system and to achieve improvements in the environment and public hygiene of the city.

It is recommended to include the capacity building and technical assistance activities in the normal engineering services of detailed design, project management, and construction supervision during pre-construction and construction periods.

(1) Detailed Design

The engineering services for detailed design include the following:

- Review all documents relating to the project including F/S and Preparatory Study reports.
- Discuss and clarify the requirements of the project with PMU and PPC.
- Prepare base maps in digital, GIS compatible format, covering Priority Project I area;
- Carry out topographic survey for sewer system design in Phase 1 Area of F/S (survey area is about 3,635 ha), including canals of Priority Project I, PS1 and STP2 sites.
- Carry out geological survey for sewer system design in Priority Project I area (total survey length is about 960 m), including canals of Priority Project I, PS1 and STP2 sites.
- Carry out dud survey for sewer routes in Priority Project I area, including canals of Priority Project I, PS1 and STP2 sites.

(2) Tender Assistance

Under this component the engineers would assist with the following:

- Pre-qualification tasks;
- Preparation and modification of tender document;
- Evaluation of bid;
- Contract negotiation.

(3) Construction Supervision

The engineering services for construction supervision include the following:

- Review the construction schedule proposed by the contractor;
- Monitor the progress of work and instruct the contractor to update the schedule when required;
- Assist PMU with progress meetings;
- Review construction shop drawings submitted by the contractor;
- Process contractor's progress and final payment requisitions and issue progress certificates for PMU/JICA approval.
- Monitor and advise PMU of the financial progress of the work;
- Advise PMU on contract variations and claims issues;
- Provide quality assurance during construction phase through supervision of civil and geotechnical engineering works and M&E plant installation work;
- Check and approve contractor's O&M manual and as-built drawings.

(4) Capacity Building

Details of capacity building are explained in Section 7.6.

(5) Information Education and Communication (IEC) Campaign

Details of the IEC campaign are explained in Section 7.9.

8.3 Project Cost Estimates

8.3.1 Measures to Reduce Project Costs

The following cost reduction measures have been considered by the study team, these measures are adopted on this project.

(1) Keeping Existing Combined Sewers

Part of the project area has an existing combined sewer system. Installing a separate sewer system in this area would be very costly therefore an interceptor sewer is proposed and new combined sewers are added to improve the existing sewer network The cost saving is equivalent to about 85km of tertiary separate sewer.

Estimated saving: 382,500 million VND (= 85 km × 4,500 million VND/km)

(2) Dividing Site Work for STP2 into 2 Stages

The STP2 site needs to be raised from the existing level of approximately +1.00m to the planning level of +3.61m. The filling work would be divided into two stages in this project. The first stage would take the level to +2.30m to avoid possible flooding. After construction of the basement structures, the second stage filling would bring the ground level to the designed specification of +3.61m, using excavated and purchased soils.

The amount of excavation, backfill and surplus soil can be reduced by carrying out fill operations in two stages. The reduction in volume and cost savings are estimated as follows,

Reduction in volume and cost savings:

Excavation = 35,000 m^3 (×38,000 VND/m^3 = 1,330 million VND)
Backfilling = 17,000 m^3 (×82,000 VND/m^3 = 1,394 million VND)
Surplus soil = 24,000 m^3 (×45,000 VND/m^3 = 1,080 million VND)
Total cost saving = 3,804 million VND

(3) Review of Maintenance Roads for Canals

The planned width of maintenance roads on both sides of canals was 5m in the F/S. The width could be scaled down to the minimum requirement of 3m to reduce land acquisition, resettlement, and construction costs. The reduction in area and cost savings are estimated as follows,

Reduction in area for land acquisition and resettlement:
181,118m^2 (= 12,937 m × (10m - 3m) ×2 sides)
Cost saving for land acquisition and resettlement:
326,000 million VND (= 181,118m^2 × 1.8 million VND)

Reduction in area for construction: 51,748m^2 (= 12,937 m × (5m - 3m) ×2 sides)
Cost saving for construction: 8,800 million VND (= 51,748m^2 × 0.17 million VND)

8.3.2 Contract Packaging

The study team recommends that the contracts be grouped into packages as follows (actual packaging to be fixed in later stages):

- The site work for STP2 to start immediately after completion of the resettlement process would be under one contract. This package group would be tendered by Local Competitive Bidding (LCB), since the construction can be carried out by a local contractor.

- The construction of the drainage and sewerage system (including the treatment plant and pump stations) would be under one contract to minimize excavation and disruption because the pipes are installed under the same road. This package would be tendered by International Competitive Bidding (ICB), since the construction would require advanced techniques, such as pipe jacking method, SCADA system and mechanical equipment for sewage and sludge treatment.

- Canal improvements would be under a separate contract because the work is quite independent of other project components. This package group would be tendered by Local Competitive Bidding (LCB), since the work can be carried out by a local contractor.

- The purchase of maintenance equipment would be under another contract to be tendered by LCB, since local trading companies can import the equipment and take care of the required maintenance and repair of the equipment in Viet Nam.

The package groups of Priority Project I are shown as the Table 8.3.1.

Table 8.3.1 Package Groups and Bidding Methods for Priority Project I

Name of Package Group	Content	Bidding Method
PACKAGE Group: Site Work for STP2	Primary Site Work for STP2	LCB
PACKAGE Group : Sewerage and Drainage Facilities	Sewerage Facilities	ICB
	Drainage Facilities	
	2.1 Bien Hung Ditch Diversion	
	Pumping Station (PS1)	
	Pumping Station (PS5)	
	STP2	
PACKAGE Group: Canal Improvement	Canal Improvement	LCB
PACKAGE Group: Maintenance Equipment	Purchasing of Maintenance Equipment	LCB

8.3.3 Construction Cost Estimate

The estimated base costs of construction and purchase of maintenance equipment are presented in Table 8.3.2. Costs are at the February 2011 price level. The estimate is for all direct costs related to construction works based on a preliminary engineering design of the sewerage and drainage systems and canal improvements. The breakdown of the cost estimate is presented in Appendix 8 - A.

The unit rates for construction in the year 2010 promulgated in “Unit price book of Dong Nai province” was used for setting the costs of basic equipment, construction materials and works. The costs of particular items not included in the book were obtained from suppliers and contractors, or based on past experience in Viet Nam. The higher of the two values is selected.

Table 8.3.2 Estimated Base Cost (February, 2011 price level)

Description	Cost		Total	Total
	Foreign	Local		
	Million yen	Million VND	Million yen	Million US$
PACKAGE Group: Site Work for STP2				
Primary Site Work for STP2	0	28,178	123	1.5
Total	0	28,178	123	1.5
PACKAGE Group : Sewerage and Drainage Facilities				
Construction Work				
Sewerage Facilities	2,903	1,282,255	8,494	102.8
Drainage Facilities	1,742	1,059,384	6,361	77.0
2.1 Bien Hung Ditch Diversion	1,245	27,839	1,367	16.5
Pumping Station-1	30	27,839	150	1.8
Pumping Station-5	45	39,863	219	2.7
STP2	594	545,382	2,972	36.0
Sub-Total	6,560	2,982,273	19,563	236.8
Equipment and Material				
Sewerage Facilities	267	0	267	3.2
2.1 Bien Hung Ditch Diversion	12	0	12	0.1
Pumping Station-1	187	0	187	2.3
Pumping Station-5	262	0	262	3.2
STP2	3,782	0	3,782	45.8
Sub-Total	4,511	0	4,511	54.6
Total	11,071	2,982,273	24,074	291.5
PACKAGE Group: Canal Improvement				
Canal Improvement	0	392,934	1,713	20.7
Total	0	392,934	1,713	20.7
PACKAGE Group: Maintenance Equipment				
Maintenance Equipment	0	167,078	728	8.8
Total	0	167,078	728	8.8
Ground Total of Construction Cost	11,071	3,570,463	26,638	322.5

The following exchange rates are used in the cost estimate in accordance with ODA loan in 2010 for Viet Nam:

Viet Nam Dong (VND) 1.0 = Japanese Yen (¥) 0.00436

US$ 1.0 = Japanese Yen (¥) 82.6 = VND 18,945

8.3.4 Operation and Maintenance Costs

Annual operation and maintenance cost for Priority Project I is estimated for the items below.

- Personnel costs for operation, maintenance and inspection of sewerage and drainage system, pumping stations and STP;
- Electricity consumption for pumping stations and STP;
- Sludge disposal fees, polymer for sludge conditioning and activated carbon for odor control for pumping stations and STP and lamp replacement for UV disinfection;
- Repair and maintenance cost for all facilities and equipment for sewer maintenance, sludge collection and transportation vehicles
- Establishment cost for new company.

Table 8.3.3 summarizes estimated operation and maintenance costs and details of estimation are provided in Appendix 8-B.

Table 8.3.3 Operation and Maintenance Costs

Items		Cost (VND/year)
1. Personnel Cost		
	Management Personnel	1,097,791,200
	Administration and Finance Personnel	6,627,682,800
	Sewerage System O&M	13,954,258,800
	Storm Water Drainage O&M Personnel	3,155,328,000
	Septic Tank Cleaning Personnel	4,338,576,000
	Sub total 1	29,173,636,800
2. Electricity Cost		
	PS1	753,709,670
	STP2 (including PS5)	15,319,539,830
	Manhole Type Pump Stations	1,529,167,500
	Sub total 2	17,602,417,000
3. Sludge Disposal and Chemical Cost		
	Sludge Disposal	3,036,800,000
	Polymer cost	148,394,400,000
	Activated carbon	4,600,000,000
	Lamp Replacement	275,000,000
	Sub total 3	156,306,200,000
4. Repairs & Maintenance Cost		
	Site Work for STP2	28,178,000
	Sewerage System (sewers, PSs, STP1)	18,547,323,299
	Drainage Facilities	1,458,990,110
	Canal	392,934,360
	Maintenance Equipment (for Sewerage Facilities)	1,805,299,729
	Maintenance Equipment (for Drainage Facilities)	1,307,286,011
	Maintenance Equipment (for Septic Tank)	1,899,755,760
	Sewer Cleaning Work: fuel (for Sanitary Sewers)	2,419,612,819
	Sewer Cleaning Work: fuel (for Drainage Sewers)	1,752,133,421
	Septage Collecting Work: fuel	1,648,121,000
	Sludge Disposal Work: fuel	369,672,000
	Standby Generator Maintenance Work: fuel	35,321,400
	Sub total 4	31,664,627,908
5. Establishment Cost		120,000,000
	Sub total 5	120,000,000
Total		203,809,031,708

Replacement of mechanical and electrical equipment and re-construction of structures are also required at intervals stated below. The costs are estimated as shown in Table 8.3.4.

- Civil structure and building - every 50-years
- Mechanical and electrical equipment - every 15-years
- Vehicle and equipment for maintenance - every 10-years

Table 8.3.4 Replacement and Re-construction Costs

Item			Cost (VND/year)
1.	Site Work for STP2		563,560,000
2.	Sewerage Facilities		
		Civil Structure and Building	60,557,938,176
		Equipment	68,975,228,400
3.	Drainage Facilities		29,179,802,192
4.	Canal		7,858,687,200
5.	Maintenance Equipment for Sewerage Facilities		6,017,665,764
6.	Maintenance Equipment for Drainage Facilities		4,357,620,036
7.	Maintenance Equipment for Septic Tank		6,332,519,200
Total			183,843,020,968

8.4 Annual Fund Disbursement

Project costs including indirect costs and price escalation over the duration of the project are presented in Table 8.4.1. Costs are based on the proposed construction schedule and annual disbursement of funds presented in Table 8.4.2. Costs required for capacity building (C/B) for management, operation, and maintenance, IEC campaign are also included. The annual disbursement for financial and economic analysis is provided in Appendix 8-C.

(1) Engineering Services

The cost of engineering services is calculated according to the service contents presented in section 8.2 of this Chapter. The costs for C/B, IEC campaign as well as detailed design, surveys, tender assistance and project management services during construction for the Priority Project I are included in the engineering services cost.

(2) Project Administration Cost

The administration costs for the PMU are taken as 3.0% of the eligible portion in accordance with Vietnamese practices of ODA loan.

(3) Import Tax

The rate used in computing import tax is 10 % of the expenditure in foreign currency of the eligible portion for construction materials.

(4) Value Added Tax (VAT)

Value added tax is taken as 10% of the eligible portion for construction and engineering services.

(5) Price Escalation

A price contingency is included in the cost estimate to cover the increase in costs of labor and materials over the duration of the project. The rates are applied in accordance with ODA loan in 2010 for Viet Nam as below.

Local currency portion: 10.5% of price escalation

Foreign currency portion: 1.8% of price escalation

Table 8.4.1 Estimated Project Cost

Description		Foreign Million yen	Local Million VND	Total Million yen	Total Million US$
A	Construction Contracts				
A.1	PACKAGE Group: Site Work for STP2	0	28,178	123	1.5
A.2	PACKAGE Group: Sewerage and Drainage Facilities	11,071	2,982,273	24,074	291.5
A.3	PACKAGE Group: Canal Improvement	0	392,934	1,713	20.7
A.4	PACKAGE Group: Maintenance Equipment	0	167,078	728	8.8
	Sub-total	11,071	3,570,463	26,638	322.5
B	Contingencies				
B.1	Physical Contingency	617	312,240	1,978	23.9
B.2	Price Contingency on Construction Works	1,279	2,674,342	12,939	156.6
	Sub-total	1,896	2,986,582	14,917	180.5
C	Engineering Services				
C.1	D/D, CB, IEC campaign SV and Survey Works	1,510	260,306	2,645	32.0
C.2	Physical Contingency	82	19,974	169	2.0
C.3	Price Contingency on Engineering Services	121	139,183	728	8.8
	Sub-total	1,712	419,463	3,542	42.8
	Total (A+B+C)	14,680	6,976,508	45,097	545.8
D	Interest During Construction	1,565	0	1,565	18.9
	Eligible Potion	16,245	6,976,508	46,662	564.7
E	Land Acquisition				
E.1	Base Cost	0	404,316	1,763	21.3
E.2	Physical Contingency	0	138,956	606	7.3
E.3	Price Contingency on Construction Works	0	58,872	257	3.1
	Sub-total	0	602,144	2,626	31.7
F	Administration Cost	0	310,303	1,353	16.4
G	Vat				
G.1	Vat (1) for Construction	0	655,705	2,859	34.6
G.2	Vat (2) for Engineering Services	0	41,946	183	2.2
	Sub-total	0	697,651	3,042	36.8
H	Import tax	0	336,692	1,468	17.8
	Non Eligible Potion	0	1,946,790	8,489	102.7
Total Project Cost		16,245	8,923,298	55,151	667.4

Table 8.4.2 Fund Disbursement Program

Annual Fund Requirement

Base Year For Cost Estimation: May, 2011 — FC & Total: million JPY
Exchange Rates: VND = yen 0.00436 — LC : million VND
Price Escalation: FC: 1.8% LC: 10.5%
Physical Contingency: 5%
Physical Contingency for Consultant: 5%
Physical Contingency for L/A & R: 30%

Item	Total			2011			2012			2013			2014		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION															
I) Procurement / Construction	12,967	6,557,045	41,556	0	0	0	0	8,173	36	0	64,411	281	269	280,184	1,491
Base cost	11,071	3,570,463	26,638	0	0	0	0	7,045	31	0	50,240	219	243	197,773	1,105
PACKAGE Groups: Site Work for STP2	0	28,178	123	0	0	0	0	7,045	31	0	21,134	92	0	0	0
PACKAGE Groups : Sewerage and Drainage Facilities															
Construction Work	6,560	2,982,273	19,563	0	0	0	0	0	0	0	0	0	243	110,455	725
Equipment and Material	4,511	0	4,511	0	0	0	0	0	0	0	0	0	0	0	0
PACKAGE Groups: Canal Improvement	0	392,934	1,713	0	0	0	0	0	0	0	29,106	127	0	87,319	381
PACKAGE Groups: Maintenance Equipment	0	167,078	728	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	1,279	2,674,342	12,939	0	0	0	0	740	3	0	11,104	48	13	69,069	314
Physical contingency	617	312,240	1,979	0	0	0	0	389	2	0	3,067	13	13	13,342	71
II) Consulting services	1,712	419,464	3,541	0	0	0	221	60,716	485	355	56,051	600	106	22,188	202
Base cost	1,510	260,306	2,645	0	0	0	207	52,330	435	326	43,719	517	95	15,662	164
Price escalation	121	139,183	727	0	0	0	4	5,495	28	12	9,663	54	5	5,470	29
Physical contingency	82	19,974	169	0	0	0	11	2,891	23	17	2,669	29	5	1,057	10
Total (I +II)	14,680	6,976,509	45,097	0	0	0	221	68,889	521	355	120,462	880	375	302,373	1,693
III) Interest during Construction	1,565	0	1,565	0	0	0	0	0	0	9	0	9	20	0	20
Total(I + II + III)	16,245	6,976,509	46,663	0	0	0	221	68,889	521	364	120,462	890	395	302,373	1,713
B. NON ELIGIBLE PORTION		30,418													
I) Land Acquisition and Resettlement	0	602,144	2,625	0	0	0	0	377,520	1,646	0	224,624	979	0	0	0
Base cost	0	404,316	1,763	0	0	0	0	262,805	1,146	0	141,511	617	0	0	0
Price escalation	0	58,872	257	0	0	0	0	27,595	120	0	31,277	136	0	0	0
Physical contingency	0	138,956	606	0	0	0	0	87,120	380	0	51,836	226	0	0	0
II) Administration cost	0	310,303	1,353	0	0	0	0	3,585	16	0	6,058	26	0	11,649	51
III) VAT(1)	0	655,705	2,859	0	0	0	0	817	4	0	6,441	28	0	28,018	122
III) VAT(2)	0	41,946	183	0	0	0	0	6,072	52	0	5,605	24	0	2,219	10
IV) Import Tax	0	336,692	1,468	0	0	0	0	5,063	22	0	8,147	36	0	8,594	37
Total (I + II + III + IV)	0	1,946,790	8,488	0	0	0	0	393,057	1,714	0	250,875	1,094	0	50,481	220
TOTAL (A+B)	16,245	8,923,299	55,151	0	0	0	221	461,946	2,235	364	371,337	1,983	395	352,853	1,933

Item	2015			2016			2017			2018			2019			2020			2021		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																					
I) Procurement / Construction	1,644	1,174,157	6,763	1,674	1,297,444	7,330	3,308	1,433,675	9,559	4,534	1,783,414	12,310	1,539	515,586	3,787	0	0	0	0	0	0
Base cost	1,458	750,046	4,728	1,458	750,046	4,728	2,831	750,046	6,101	3,811	844,358	7,493	1,270	220,909	2,234	0	0	0	0	0	0
PACKAGE Groups: Site Work for STP2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PACKAGE Groups : Sewerage and Drainage Facilities																					
Construction Work	1,458	662,727	4,347	1,458	662,727	4,347	1,458	662,727	4,347	1,458	662,727	4,347	486	220,909	1,449	0	0	0	0	0	0
Equipment and Material	0	0	0	0	0	0	1,373	0	1,373	2,354	0	2,354	785	0	785	0	0	0	0	0	0
PACKAGE Groups: Canal Improvement	0	87,319	381	0	87,319	381	0	87,319	381	0	14,553	63	0	0	0	0	0	0	0	0	0
PACKAGE Groups: Maintenance Equipment	0	0	0	0	0	0	0	0	0	0	167,078	728	0	0	0	0	0	0	0	0	0
Price escalation	108	368,199	1,713	136	485,615	2,253	320	615,359	3,003	507	854,131	4,231	195	270,125	1,373	0	0	0	0	0	0
Physical contingency	78	55,912	322	80	61,783	349	158	68,270	455	216	84,924	586	73	24,552	180	0	0	0	0	0	0
II) Consulting services	245	55,566	487	182	54,632	420	182	62,206	453	192	65,253	476	181	35,950	338	49	6,902	79	0	0	0
Base cost	217	35,496	372	159	31,582	296	156	32,544	298	161	30,894	296	150	15,403	217	40	2,676	51	0	0	0
Price escalation	16	17,425	92	15	20,448	104	18	26,700	134	21	31,252	158	23	18,835	105	7	3,897	24	0	0	0
Physical contingency	12	2,646	23	9	2,602	20	9	2,962	22	9	3,107	23	9	1,712	16	2	329	4	0	0	0
Total (I +II)	1,889	1,229,724	7,251	1,855	1,352,076	7,751	3,490	1,495,882	10,012	4,726	1,848,666	12,786	1,720	551,536	4,125	49	6,902	79	0	0	0
III) Interest during Construction	67	0	67	118	0	118	184	0	184	268	0	268	297	0	297	299	0	299	301	0	301
Total(I + II + III)	1,957	1,229,724	7,318	1,974	1,352,076	7,869	3,674	1,495,882	10,196	4,994	1,848,666	13,054	2,017	551,536	4,422	348	6,902	378	301	0	301
B. NON ELIGIBLE PORTION																					
I) Land Acquisition and Resettlement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II) Administration cost	0	49,890	218	0	53,329	233	0	68,890	300	0	87,977	384	0	28,380	124	0	544	2	0	0	0
III) VAT(1)	0	117,416	512	0	129,744	566	0	143,368	625	0	178,341	778	0	51,559	225	0	0	0	0	0	0
III) VAT(2)	0	5,557	24	0	5,463	24	0	6,221	27	0	6,525	28	0	3,595	16	0	690	3	0	0	0
IV) Import Tax	0	43,327	189	0	42,556	186	0	80,046	349	0	108,389	473	0	39,448	172	0	1,123	5	0	0	0
Total (I + II + III + IV)	0	216,190	943	0	231,093	1,008	0	298,524	1,302	0	381,233	1,662	0	122,982	536	0	2,357	10	0	0	0
TOTAL (A+B)	1,957	1,445,913	8,261	1,974	1,583,169	8,876	3,674	1,794,406	11,498	4,994	2,229,899	14,717	2,017	674,517	4,958	348	9,259	389	301	0	301

Administration Cost = 3.0% of the Eligible portion
VAT(1)= 10% of the expenditure in local currency of the eligible portion for construction material and works
VAT(2)= 10% of the expenditure in local currency of the eligible portion for consulting services
Import Tax 10% of the expenditure in foreign currency of the eligible portion

CHAPTER 9 FINANCIAL AND ECONOMIC ANALYSIS

9.1 Financial Analysis

9.1.1 Financial Conditions of Concerned Organizations

(1) Dong Nai Province

Table 9.1.1 shows the revenue and expenditure of Dong Nai Provincial Government. Its revenue structure consists of domestic tax revenue, customs duty, and others. Its expenditure for development investment accounted for about VND 1,490 billion in 2009; of which approximately 5.4% (VND 80.6 billion) was spent for construction activities by PMU in the sewerage and drainage sector.

Table 9.1.1 Revenue and Expenditure of Dong Nai Province

				Unit: Million VND
	2007	2008	2009	Budget 2010
Revenue	**12,196,385**	**15,251,055**	**14,577,716**	**14,428,000**
A. Revenue in area	10,487,995	12,871,069	14,127,716	14,008,000
1. Revenue from domestic	7,001,891	7,708,647	8,235,326	8,858,000
2. Custom duty revenue	3,486,104	4,771,810	5,442,390	5,150,000
3. Revenue from lottery		390,612	450,000	-
B. Other revenue	903,235	1,771,339	-	-
C. Retained Revenue for managing through government budget	805,155	608,647	450,000	420,000
Expenditure	**6,482,990**	**8,059,250**	**5,011,667**	**5,134,983**
A. Total expenditure of State budget	4,462,701	5,837,154	4,596,055	4,714,983
1. Expenditure on development investment	1,123,727	1,273,773	1,489,667	1,367,656
2. Expenditure on social and economic services	2,358,373	2,732,294	2,863,478	3,129,229
3. Addition to financial reserve fund	2,910	2,910	2,910	2,910
4. Others	977,691	1,828,177	240,000	215,188
B. Expenditure from retained revenue for managing through government budget	742,403	970,735	415,612	420,000
C. Expenditure additional to junior budget	1,275,833	1,251,361	-	-
D. Pay senior budget	2,053	-	-	-

Source: Dong Nai Statistical Yearbook 2009 and Dong Nai Department of Finance

(2) PMU

The financial status of PMU is shown in Table 9.1.2. Almost fully funded by the DNPPC budget, in 2010 PMU spent VND 24,697 million for construction works in the drainage and sewerage sector. Its expenditure for operation has grown by approximately 8 times from 2006 to 2010, showing the increasing importance of drainage and sewerage investment in the province. The entire scale of the budget fluctuates significantly from one year to the next depending on the amounts available for DNPPC and progress in construction works.

Table 9.1.2 Revenue and Expenditure of PMU

					Unit: VND million
	2006	**2007**	**2008**	**2009**	**2010**
A. Revenue	**4,489**	**720**	**19,367**	**83,841**	**28,885**
Budget from government	4,439	246	19,241	83,786	28,772
Accounts Receivable	51	321	79	18	98
Other Revenue	0	153	46	37	15
B. Expenditures	**4,010**	**592**	**18,266**	**83,018**	**28,062**
Construction in progress	2,952	57	16,345	80,581	24,697
PMU operation expenditure	386	365	1,255	2,304	3,059
Accounts Payable	673	170	665	110	300
Other Payables	0	0	0	23	6

Source: PMU

(3) URENCO Bien Hoa

With a relatively small amount of its revenue generated by fees for garbage collection, URENCO also heavily relies on funding from DNPPC. Every year it prepares a budget and submits it to the DNPPC for approval. The funding is negotiated with the Department of Finance (DOF) and Department of Planning and Investment (DPI) of DNPPC, on matters related to recurrent cost and investment cost, respectively, and subject to final approval by DNPPC. Table 9.1.3 shows the balance sheet and income statement of the company.

Table 9.1.3 Balance Sheet and Income Statement of URENCO Bien Hoa

Unit: VND million

	2006	2007	2008	2009	2010
Balance Sheet					
Assets					
Current Assets	**43,476**	**53,538**	**66,941**	**83,131**	**116,139**
Cash & Short-term Investment	27,232	38,109	45,337	43,706	64,067
Accounts Receivable	2,750	3,184	5,986	21,841	39,703
Inventories	13,438	12,245	15,201	17,352	12,225
Others	56	0	417	231	143
Long-term Assets	**62,895**	**83,416**	**83,320**	**85,162**	**86,152**
Fixed Assets (Net)	62,473	80,564	77,968	79,810	81,152
Fixed Assets	*43,158*	*73,133*	*81,974*	*92,985*	*99,397*
Accumulated Depreciation	*-15,660*	*-20,676*	*-27,808*	*-37,758*	*-47,970*
Construction in Process	*34,974*	*28,107*	*23,802*	*24,582*	*29,726*
Others	422	2,852	5,352	5,352	5,000
Total Assets	**106,371**	**136,954**	**150,260**	**168,292**	**202,291**
Liabilities and Equity					
Liabilities	**20,519**	**25,544**	**24,138**	**23,608**	**47,721**
Short-term Liabilities	20,114	25,065	23,431	22,600	46,414
Long-term Liabilities	406	479	707	1,008	1,307
Equity	**85,851**	**111,410**	**126,122**	**144,684**	**154,570**
Owner's Equity Investment	31,002	58,753	67,978	78,157	78,660
Retained Earnings after Tax	0	0	5,445	15,966	20,278
Other Equity	42,401	34,259	28,657	31,687	50,266
Other Capital and Funds	12,448	18,398	24,042	18,874	5,366
Total Liabilities and Equity	**106,371**	**136,954**	**150,260**	**168,292**	**202,291**
Income Statement					
Revenue	**71,755**	**92,002**	**108,500**	**138,704**	**176,876**
Budget Allocation from PC	42,275	57,405	64,944	N/A	N/A
(% of Revenue)	*(59%)*	*(62%)*	*(60%)*	*N/A*	*N/A*
of which: Wastewater/ Drainage	*4,970*	*6,546*	*7,497*	*N/A*	*N/A*
of which: Solid Waste & Septic Tank Sludge	*15,102*	*19,297*	*24,128*	*N/A*	*N/A*
Sales from Private & Public Services	30,450	34,596	43,555	N/A	N/A
(% of Revenue)	*(42%)*	*(38%)*	*(40%)*	*N/A*	*N/A*
of which: Solid Waste & Septic Tank Sludge	*19,133*	*19,631*	*25,049*	*N/A*	*N/A*
Cost of Goods Sold	**58,188**	**73,711**	**88,904**	**113,196**	**146,633**
of which: Wastewater/ Drainage	*298*	*334*	*598*	*N/A*	*N/A*
of which: Solid Waste & Septic Tank Sludge	*23,015*	*25,341*	*32,460*	*N/A*	*N/A*
Gross Profit from Sales	**13,566**	**18,290**	**19,595**	**25,508**	**30,243**
Financial Income	436	484	2,711	3,576	3,331
Administration Expenses	4,942	5,901	7,243	7,726	9,087
Net Profit from Operation	**9,060**	**12,874**	**15,063**	**21,358**	**24,487**
Other Income	33	99	153	690	642
Other Expenses	71	35	4	589	69
Net Profit before Tax	**9,022**	**12,937**	**15,212**	**21,459**	**25,060**
Business Income Tax Expense	2,588	3,663	4,199	5,493	6,137
Net Profit after Tax	**6,434**	**9,274**	**11,013**	**15,966**	**18,923**

Source: URENCO Bien Hoa

URENCO is only able to earn around 40% of its sales revenue from the services it provides. The remaining revenue is covered by funds allocated by DNPPC and Bien Hoa CPC. URENCO completely relies on external funding for its sewerage and drainage services. The expenditure amount allocated to sewer and drain maintenance in 2008 is only VND 598 million and accounts for less than 1% of the company's total operational cost. Although the expenditure for sewer/drain maintenance has increased to keep pace with the expansion of the network, JICA Study Team is of the opinion that the maintenance function is underfunded.

9.1.2 Sewerage Tariff System

In Viet Nam, the sewerage tariff and the environmental protection fee (EPF) are applied according to the relevant regulations and charged based on the water consumption.

(1) Water Tariff

The water tariff is based on Decision Ref No. 54/QD-UBND dated July 30, 2009 issued by DNPPC and Decision Ref No. 50/QD.HDTV dated August 4, 2009, issued by DNWSCC. Billing is based on metered consumption. The latest water tariff is presented in Table 9.1.4. Based on the recent average water consumption in the project area (137 l/c/d or 20.55 m^3 per month for a household of five persons), the average monthly water charge is VND 89,294 per household. The generally accepted maximum ability-to-pay level is 4% to 5% of household income[1]. According to results of the willingness-to-pay survey 95.5% of the households have monthly income more than VND 2 million therefore the average water charge is deemed affordable. Compared to the median value of household income (VND 6 million to VND 7 million), the average water charge accounts for 1.3% to 1.5%.

Table 9.1.4 Water Tariff Structure

Category of Customer	Category of Consumption	Unit Price (VND/m^3)
1) Household	up to 10 m^3/month	3,600
	over 10 to 20 m^3/month	5,000
	over 20 to 30 m^3/month	6,000
	over 30 m^3/month	9,000
2) Government organizations	all consumption	6,000
3) Direct Sales at WTP to water tankers, and so on	all consumption	6,200
4) Bulk Sales to Industrial Zones	all consumption	5,800
5) Public Service and Private Enterprise	all consumption	12,000
6) Raw water supply	all consumption	3,000
7) Minimum charge	4 m^3/month	14,400

Source: DNWSCC

(2) Sewerage Tariff

Since there is no public centralized sewerage treatment system at present, no sewerage tariff is applied to sewer users in Bien Hoa City except for the privately managed systems in industrial

[1] ADB (1999) "Handbook for the Economic Analysis of Water Supply Project" and JICA (2002) "Research on the Economic Evaluation Methodology in Development Study"

zones. According to the central government decree No.88/2007/ND-CP and circular No.09/2007TT-BXD, the following principles must be applied to Viet Nam's sewerage tariffs:

- Objectives of tariff introduction:
  - ➢ To generate a sufficient and stable revenue for the sewerage service provider that enables it to become a financially autonomous organization and deliver better services to the public;
  - ➢ To guarantee proper and long-time operation and maintenance, thus sustainability of investments into sewerage systems.
- Polluters-pay principle: All organizations and households who discharge into a sewerage system are obliged to pay a sewerage tariff. Those discharging sewage directly to the environment shall pay an environment protection fee.
- Cost recovery: The revenue from tariffs must cover at least the costs for operation and maintenance as well as a part of the capital expenditure. Local funding must be ready to cover those costs in case that approved tariffs are insufficient for full cost recovery.
- Approval and regulation of tariff: Sewerage system operators must establish and submit a tariff proposal, DOC of PPC must check it in coordination with DOF of PPC and submit it to PPC for approval.
- Ability-to-pay: The sewerage tariff must not exceed 2% - 3% of the monthly average income of customers.

Section 9.1.4 of the report takes into account the aforementioned principles for financial projection of the proposed project.

(3) Environmental Protection Fee

The environmental protection fee for sewage discharge is identified in DNPPC Decision 3510/2004/QD.UBT dated August 9, 2004 following the central government resolution No.67/2003/ND-CP dated June 13, 2003. The decision states that every water bill shall include a 10% surcharge for the discharge of sewage. Therefore the amount collected depends on the volume and value of the water sold by DNWSCC.

The environmental protection fee is collected by the water supply company from every metered connection regardless of whether or not customers are connected to a sewer system. In accordance with the said decision, 7% of the environmental fee is kept by DNWSCC for its administration cost; the remaining 93% was until recently divided equally and transferred to the central government (Environmental Protection Fund) and DNPPC . A recent amendment by government decree No.26/2010/ND-CP dated March 22, 2010, stipulates that the full amount (93%) shall be transferred directly to DNPPC. DNWSCC customers in industrial zones are exempt from the fee because they have their own sewerage treatment facilities.

Information on exactly how much money the water supply company collected in 2010 for the environmental protection fee was not provided by DNWSCC. JICA Study Team estimates that in 2009 DNWSCC collected about VND 880 million from the environmental protection fee; and after deducting 7% for administration cost, VND 818 million would have been transferred[2] to DNPPC.

9.1.3 Fund Flow for Current Sewerage/Drainage Services

The funds generated by the environmental protection fee are not transferred directly to URENCO or PMU and they are not segregated from other funds at DNPPC. As presented in the previous sections, both URENCO and PMU rely on funding from DNPPC to meet their operating costs and their revenue stream is not related to the environmental protection fee. Hence, the present financial management structure does not ensure the sustainability of sewerage and drainage development projects because it is not based on the principles of full cost recovery as prescribed in Decree No.88.

9.1.4 Financial Projection of Sewerage/Drainage Service

A financial projection is carried out to examine the feasibility of increasing the environmental protection fee or implementing a sewerage tariff to reduce the subsidy required from the government.

(1) Costs and Funding

Project cost and O&M cost estimated in Chapter 8 are applied to the financial projection. All costs are expressed in 2011 constant price; and price escalation and interest during construction are not considered (See Table 9.1.5 and Table 9.1.6). It is assumed that the tariff collection will be made in the same manner as the present situation; i.e. DNWSCC will collect the sewerage/drainage surcharge on water bills from its customers. Hence, 7% administration cost is assumed to be deducted by DNWSCC from the tariff revenue in this analysis.

According to MOF Circular No.108/2003/TT-BTC dated November 7, 2003, ODA loans for sewerage and drainage projects are entirely allocated from the state budget; i.e. the loan will not be on-lent from the central government to local government or the sewerage service provider. The same MOF Circular states that counterpart funding for the project is local government’s responsibility, whereas DNPPC has decided that the counterpart fund would be allocated from the state budget. PMU is of the opinion that the issue will be discussed after the completion of the present study when the funding needs have been determined. In this analysis it is assumed that the initial counterpart funding would be provided by either central or local government, not by the sewerage service provider.

[2] According to Table 3.1.3 of Phase I JICA Study Final Report, total water consumption was 49,565 m^3/d except industrial zones.

Table 9.1.5 Project Cost (Financial)

Unit: VND million

	Sewerage Component	Septage Collection	Drainage Component	Total
TOTAL	**6,186,231**	**75,135**	**2,463,896**	**8,725,262**
Eligible Portion	**5,018,727**	**66,491**	**2,190,927**	**7,276,146**
Procurement and Construction	**4,582,358**	**66,491**	**1,990,276**	**6,639,125**
Base Cost	4,150,880	63,325	1,895,501	6,109,706
1. Site Work for STP 2	*28,178*	*0*	*0*	*28,178*
2. Sewerage and Drainage Facilities	*4,062,525*	*0*	*1,458,990*	*5,521,515*
3. Canal Improvement	*0*	*0*	*392,934*	*392,934*
4. Maintenance Equipment	*60,177*	*63,325*	*43,576*	*167,078*
Physical Contingency	207,544	3,166	94,775	*305,485*
Disbursements to Revolving Fund	223,934	0	0	223,934
Consulting Services	**436,370**	**0**	**200,651**	**637,021**
Consulting Services Base Cost	415,590	0	191,097	606,687
Physical Contingency	20,780	0	9,555	30,334
Non-eligible Portion	**1,167,504**	**8,644**	**272,968**	**1,449,116**

Table 9.1.6 O&M Cost (Financial)

Unit: VND million

	Sewerage Component	Septage Collection	Drainage Component	Total
TOTAL (A + B + C)	**338,421**	**15,402**	**50,824**	**404,647**
Total Direct and Indirect O&M Cost (A + B)	**202,307**	**9,069**	**9,428**	**220,804**
A. Direct O&M Cost	**175,919**	**7,886**	**8,198**	**192,004**
1. Personnel	24,028	4,339	3,287	31,653
2. Electricity	15,842	0	0	15,842
3. Chemical	112,724	0	0	112,724
4. Repairs and Maintenance	23,205	3,548	4,911	31,665
5. Establishment Cost	120	0	0	120
B. Indirect O&M Cost	**26,388**	**1,183**	**1,230**	**28,801**
C. Annual Depreciation Cost	**136,114**	**6,333**	**41,396**	**183,843**
1. Annual Depreciation (Equipment & Machines)	74,993	6,333	4,358	85,683
2. Annual Depreciation (Construction)	61,121	0	37,038	98,160

(2) Tariff Structure and Case Scenarios

Although Decree No.88 identifies the need to implement polluters-pay and cost-recovery principles, PMU is of the opinion that the costs incurred from the project would be covered by increasing the environmental protection fee to all the water consumers in Dong Nai Province even if they are not connected to the sewerage system. This practice has been common in other Vietnamese sewerage projects in order to avoid implementing unaffordable sewerage tariff charged only to the connected residents due to the heavy project cost.

Taking the aforementioned into consideration, the financial analysis estimates the required tariff and subsidy levels for several cases presented in Table 9.1.7.

Table 9.1.7 Case Scenarios

Case	Description	Depreciation Cost		
		A	B	C
		Not Included	Including Depreciation Cost for Equipment and Machines	Including Depreciation Cost for All Works
Case 1 **EPF Increase**	- Increase EPF to be collected from all DNWSCC customers (Domestic and Others. Industrial Zones excluded.) to cover O&M cost (direct & indirect) - Septage collection is excluded from EPF estimation - Depreciation cost and debt service are subsidized by government	**Case 1A** **Only O&M (Base Case)**	**Case 1B** **O&M + E&M Dep**	**Case 1C** **O&M + All Dep**
Case 2 **Sewerage Tariff According to Decree 88**	- Establish new "sewerage tariff" to be charged to connected customers to cover sewerage O&M cost - EPF is charged to All DNWSCC customers separately to cover the drainage O&M cost - Depreciation cost and debt service are subsidized by government	**Case 2A** **Only O&M**	-	-

In all cases the debt service and initial counterpart budget are assumed to be subsidized. In Case 1 the increased environmental protection fee will be charged equally to all the DNWSCC customers in Dong Nai Province[3], whereas in Case 2, as stated in Decree No.88, the newly established sewerage tariff will be charged only to sewerage service users with house connections in the project area who no longer use domestic septic tanks. In Case 1 average tariffs are calculated for three depreciation cost options ((A) none, (B) only equipment and machines and (C) all depreciation cost). In Case 2 the O&M cost of the drainage component are separated and covered by an environmental protection fee charged to all DNWSCC customers. It is assumed that the 10% environmental protection fee remains charged to all DNWSCC customers; and the analysis will estimate its percentage necessary to cover the costs incurred from the drainage component of the project.

Process to implement the new sewerage tariff is stated in Article 55 of Decree No.88. First, the sewerage works owner (SDCC) submits sewerage tariff proposal; and DOC and DOF of PPC appraise the proposed alternatives. PPC shall determine the tariff for the subject city/town following the discussion with Provincial People’s Council.

In all cases the costs related to septage collection (O&M and depreciation costs) are separately calculated to estimate septage collection charge.

(3) Water Tariff

Tariffs are calculated in terms of payment by water consumption volume, or VND/m^3. It is also

[3] It is assumed that the DNWSCC customers in industrial zones are exempt from the environmental protection fee because they have their own wastewater treatment systems.

expressed as a percentage surcharge on the water tariff in the same way as the current environmental protection fee. The current cross-subsidy level among customer segments used for water tariffs is applied in the present analysis. Table 9.1.8 shows the average water tariff proposed for 2011 by JICA Study team which is applied in the following estimate.

Table 9.1.8 Water Tariff

	VND/m3	Ratio
Domestic	4,320	23.1%
Other Services	14,400	76.9%

Source: JICA Phase II Water Supply Study Team

(4) Water Consumption

All the DNWSCC customers are subject to the environmental protection fee in Case 1 whereas only the customers in the sewerage project area are subject to the sewerage tariff in Case 2. Water consumption from 2020 is estimated on the assumptions shown in Table 9.1.9.

Table 9.1.9 Water Consumption Projection

Unit: m3/d

	Present 2010	Projection 2020	Remarks
Dong Nai Province Total	**123,893**	**764,612**	
Domestic	41,311	310,427	2005 Master Plan projection is adjusted based on: Unit Consumption Bien Hoa 120 lcd, Others 100 lcd Service Ratio Bien Hoa 95%, Others 90%
Industrial Zones	74,328	381,472	2005 Master Plan Projection. Not considered in EPF projection
Other Services	8,254	72,713	Percentage to domestic consumption volume is based on 2005 Master Plan
Project Area Total	**17,525**	**34,122**	
Domestic (Combined Sewer)	-	10,395	165 lcd * population 63,000
Domestic (Separate Sewer)	-	20,625	165 lcd * population 125,000
Other Services (Combined)	-	1,040	10% of domestic consumption volume
Other Services (Separate)	-	2,063	10% of domestic consumption volume

Source: JICA Preparatory Study Phase I and Water Supply Master Plan (2005)

(5) Ability-to-pay of Domestic Customers

The estimated tariff is compared with the average (or median) household income to assess customers' ability to pay. According to Circular No.09/2007TT-BXD, the sewerage tariff must not exceed 2% - 3% of the monthly average income of customers. In this analysis the median value of VND 6 million is applied to such comparison.[4] 2% of this median income is equivalent to VND 120,000 per month; which accounts for 185% (VND 8,000/m^3) of the average water bill for a 100

[4] According to Dong Nai Statistical Office (2010) "Statistical Yearbook 2009", the average monthly income is VND 1.5 million per capita (VND 7.5 million for a household of five persons) whereas the willingness-to-pay survey results suggests the same level of average household income, but its median values (generally considered more appropriate to illustrate the prevailing income level) ranges between VND 6 million and VND 7 million.

l/c/d household of five persons in Dong Nai Province and 112% (VND 4,848/m^3) for a 165 l/c/d household in the project area. The proposed water tariff setting is still as low as 1% to 1.7% of the household income.

(6) Results: Case 1 (Environmental Protection Fee for All DNPPC Customers)

Results for Case 1 are presented in Table 9.1.10. Since the project's O&M cost is equally distributed to all DNWSCC customers, even in Case 1C which includes all depreciation cost, the environmental protection fee percentage is 72% in 2021 (after commissioning of the project) and only 0.78% of the household income.

Table 9.1.10 Environmental Protection Fee Estimation (Case 1)

Case	Environmental Projection Fee Projection							Household Payment vs Income	Additional Subsidy Requirement
	EPF (% to Water Tariff)			EPF Rate (VND/Water Volume m3)		Average Household Payment per Month			Annual Depreciation Cost (VND million per year)
	2019	2020	2021 -	Domestic	Other Services				
Case 1A (Base Case)	23%	36%	**39%**	1,694	5,648	DNP Urban Domestic Use (100 lcd)	25,416	**0.42%**	**177,511**
Case 1B (+ E&M Depreciation)	23%	51%	**54%**	2,329	7,765	DNP Urban Domestic Use (100 lcd)	34,941	**0.58%**	**98,160**
Case 1C (+ All Depreciation)	23%	69%	**72%**	3,115	10,383	DNP Urban Domestic Use (100 lcd)	46,724	**0.78%**	-

In Case 1A which excludes all depreciation cost from the fee calculation, the additional subsidy requirement amounts to VND 177,511 million or 3.5% of Dong Nai Province's annual expenditure in 2009. In Case 1B where the depreciation cost for equipment and machinery is covered by the fee, the additional subsidy requirement is VND 98,160 million or 2.0% of the province's expenditure.

In addition to the proposed project, it is anticipated that other sewerage projects in Dong Nai Province will further increase the fiscal responsibility of the provincial government in the future. PMU is of the opinion that while it aims at gradual increase of the environmental protection fee keeping pace with the socio-economic development of the province, DNPPC will need to make budgetary appropriation to subsidize the sewerage and drainage service to fill in the financial gap.

The required environmental protection fee percentage is inversely related to the water consumption volume of customers in Dong Nai Province during the operating period. Case 1C results based on different per capita water consumptions are presented in Table 9.1.11. In the case where water consumption is 60% of the projected amount (i.e. 60 l/c/d for domestic), the fee would have to go up to 120% to provide the same amount of revenue.

Table 9.1.11 Environmental Protection Fee Estimation (Case 2)

Case	Environmental Projection Fee Projection							
	EPF (% to Water Tariff)			EPF Rate (VND/Water Volume m3)		Average Household Payment per Month		Household Payment vs Income
	2019	2020	2021 -	Domestic	Other Services			
Case 1C (100 lcd)	23%	69%	72%	3,115	10,383	DNP Urban Domestic Use (100 lcd)	46,724	0.78%
Case 1C (80 lcd)	28%	86%	90%	3,894	12,979	DNP Urban Domestic Use (80 lcd)	46,724	0.78%
Case 1C (60 lcd)	38%	115%	120%	5,192	17,305	DNP Urban Domestic Use (60 lcd)	46,724	0.78%

(7) Results: Case 2 (Sewerage Tariff for Connected Customers)

Results for Case 2 are presented in Table 9.1.12.

Table 9.1.12 Sewerage Tariff Estimation

Case	Sewerage Tariff Projection								Additional Subsidy Requirement			
	Sewerage Tariff (% to Water Tariff)			Wastewater Tariff Rate (VND/Water Consumption m3)		Average Household Payment per Month (VND)		Household Payment vs Income	Subsidy to O&M Cost to Keep Tariff at 2% of Income (VND/m3)	**Subsidy to O&M Cost (VND million/year)**	**Depreciation Cost (VND million/year)**	**Total Subsidy (VND million/year)**
	2019	2020	2021 -	Domestic	Other Services							
Case 2A (Only Sewerage O&M Cost)	185%	306%	334%	14,410	48,032	Project Area Domestic Use (165 lcd)	356,640	5.94%	8,892	**100,677**	**136,114**	**236,791**

Case	Environmental Protection Fee Projection							
	EPF (% to Water Tariff)			EPF Rate (VND/Water Consumption m3)		Average Household Payment per Month (VND)		Household Payment vs Income
	2019	2020	2021 -	Domestic	Other Services			
Case 2A (EPF for Drainage O&M + All Dep.)	1.3%	9.4%	9.4%	407	1,356	DNP Urban Domestic Use (100 lcd)	6,101	0.10%

The sewerage tariff charged to the project area customers would be 334% of the water tariff, which is 5.94% of the median household income and deemed to exceed the ability-to-pay level of 2%. A subsidy of VND 236,791 million in total would be needed to cover a part of O&M and all depreciation costs if the tariff was set to 2% of the average household income. The required subsidy accounts for 4.7% of the annual expenditure of Dong Nai Province in 2009. The environmental protection fee charged to all DNWSCC customers to cover O&M and depreciation costs of the drainage components would be 9.4%.

(8) Results: Septage Collection Charge

The septage collection charge is estimated based on the O&M and depreciation cost related to the septic tank cleaning work (Table 9.1.13). Based on the two-year cleaning cycle at each household using septic tanks, the charge is estimated as VND 240,000 per visit. Since the base O&M cost does not include treatment works, the charge is relatively less than the common price currently paid by a household (VND 500,000 to VND 800,000).

Table 9.1.13 Septage Collection Charge

		Unit	Amount	Remarks
Septage Collection		VND million	**15,402**	Annual cost from 2021
	Direct O&M Cost	VND million	7,886	
	Indirect Cost	VND million	1,183	15% of Direct Cost
	Depreciation Cost	VND million	6,333	Vehicles, etc.
Annual Septage Amount		m^3	25,680	642,000 persons at annnual amount 0.04m3
Average Cost		VND/m3	599,764	Average septage charge amount per m3
Septage Amount per HH/time		m^3	0.40	0.04 m3 * 5 persons * 2 year interval
Annual Septage Amount		VND/time	**239,906**	Septic tank cleaning in 2 year cycle

9.2 Economic Analysis

Economic analysis is carried out to evaluate the project's economic viability through cost-benefit analysis based on discounted cash flow projection. In accordance with the study TOR, sewerage and drainage project components are assessed separately.

9.2.1 Basic Assumptions

The following basic assumptions are applied for both project components:

- Project lifetime 50 years after commissioning
- Economic Cost

  Capital expenditure (initial investment and reinvestment required over the lifetime)

  O&M Cost (direct and indirect O&M cost)
- All prices are expressed in 2011 constant price. Price escalation, taxes, interest during construction, depreciation cost, and land acquisition costs are excluded from calculation. Standard conversion factor of 0.9 is applied to acquire economic values of local currency costs.
- The threshold for economic viability of the project is set at 8% considering recent similar Japanese ODA loan projects in Viet Nam in the sewerage and drainage sector[5].

[5] EIRRs shown in JICA's ex-ante evaluation results of ODA loan projects in the sewerage and drainage sector in Viet Nam over the recent five years range from 5.3 to 10.8.

9.2.2 Project Cost

Project costs are converted into economic values based on the costs estimated in Chapter 8 and following the basic assumptions presented above.

(1) Construction Cost

Economic costs projected for each component are estimated as per Table 9.2.1. Detailed calculation and annual projection is presented in Appendix 8-C.

Table 9.2.1 Construction Cost (Economic)

Unit: VND million

	Sewerage Component	Drainage Component	Total
TOTAL	**4,973,230**	**2,083,837**	**7,057,067**
Eligible Portion	**4,828,379**	**2,023,143**	**6,851,522**
Procurement and Construction	**4,408,626**	**1,833,207**	**6,241,833**
Base Cost	4,006,748	1,745,911	5,752,660
1. Site Work for STP 2	*25,360*	*0*	*25,360*
2. Sewerage and Drainage Facilities	*3,870,236*	*1,353,052*	*5,223,288*
3. Canal Improvement	*0*	*353,641*	*353,641*
4. Maintenance Equipment	*111,152*	*39,219*	*150,370*
Physical Contingency	200,337	87,296	*287,633*
Disbursements to Revolving Fund	201,540	0	201,540
Consulting Services	**419,753**	**189,936**	**609,689**
Consulting Services Base Cost	399,765	180,892	580,656
Physical Contingency	19,988	9,045	29,033
Non-eligible Portion	**144,851**	**60,694**	**205,546**

(2) Reinvestment in Equipment and Machine Replacements

It is assumed that both project components (sewerage and drainage) require replacement costs for equipment and machines as per Table 9.2.2 depending on the economic lifetime. No residual value is assumed at the end of project lifetime.

Table 9.2.2 Reinvestment Cost (Economic)

Unit: VND million

	Replacement Cycle	Sewerage Component	Drainage Component	Total
Sewerage and Drainage Facilities	15 Years	1,083,461	2,899	1,086,360
Maintenance Equipment	10 Years	116,709	41,180	157,889

(3) O&M Cost

Annual O&M costs are converted into economic values as per Table 9.2.3. Detailed calculation and annual projection is presented in Appendix 8-C.

Table 9.2.3 O&M Cost (Economic)

Unit: VND million

	Sewerage Component	Drainage Component	Total
Total O&M Cost	**192,151**	**8,531**	**200,682**
A. Direct O&M Cost	**167,087**	**7,418**	**174,506**
1. Personnel	25,530	2,958	28,488
2. Electricity	14,258	0	14,258
3. Chemical	101,451	0	101,451
4. Repairs and Maintenance	25,740	4,460	30,201
5. Establishment Cost	108	0	108
B. Indirect O&M Cost	**25,063**	**1,113**	**26,176**

9.2.3 Sewerage Component

(1) Economic Benefit

The project will provide a number of economic benefits, The following benefits are included in the cost-benefit analysis:

<u>Direct Benefits</u>

(a) Avoided sanitation cost

It is considered that the costs related to the use of septic tanks in the project area will be avoided with the implementation of the sewerage project. The avoided sanitation cost per connection is estimated as shown in Table 9.2.4. The annual economic benefit is calculated as VND 26,738 million for 37,500 connections.

Table 9.2.4 Septic Tank Cost Estimation

Unit: VND

	Cost	Remarks
Septic Tank Construction Cost	**11,752,000**	Capacity 4.25m^3 for Household of five persons
Lean Concrete Layer	413,000	Thick 100mm, Grade 150
R.C. Bottom and Cover Slab	2,302,000	Steel Mesh of 150*150 Dn14
Masonry Work	3,978,000	Solid brick walls of 200mm thick plus 2 layers of cement mortar pastes for coating and waterproof puposes
Pipes and Fittings	1,209,000	
Backfilling and Refurbishing Work	3,850,000	
Annual Depreciation over 30 Years	**392,000**	**Construction cost / 30 years**
Annual Septic Tank Cleaning Cost	**400,000**	**VND 800,000 /time (two-year cycle)**
Total Annual Cost	**792,000**	
Economic Value	**713,000**	**Standard Conversion Factor =0.90**

(b) Avoided healthcare cost of water borne diseases

Sanitary sewerage service provided by the project will reduce the risk of water borne diseases thereby saving healthcare costs. In Bien Hoa, the reported diarrheal diseases (dysenteric diarrheas and dysentery) are 2,653 cases in total. Based on a study conducted by World Bank (2008) on the economic impacts of sanitation in Viet Nam[6], the number of peope affected by diarrheal diseases in the project area are estimated in (Table 9.2.5):

Table 9.2.5 Diarrheal Disease Cases and Treatment Seeking Behavior by Provider

Health Care Provider	Unit	Public Provider	Private Clinic	Self Treatment	No Treatment	Total	Remarks
Nationwide Diarrheal Disease Cases	Cases	964,420	1,370,737	5,219,670	360,960	7,915,787	World Bank (2008)
	%	12.2%	17.3%	65.9%	4.6%	100.0%	
Diarrheal Disease Cases in Project Area (2020)	Cases	773	1,099	4,185	289	6,347	Nationwide proportion is applied to estimate other cases than treatment by public provider.
Adjusted for Unreported Cases	Cases	851	-	-	-	-	10% of reported cases (World Bank 2008)
Attributable to Poor Sanitation	Cases	749	967	3,683	255	5,653	88% of cases (World Bank 2008) 5,399 patients are treated
Hospitalized Cases	Cases	37	48	-	-	86	5% of Public and Private Clinics
Outpatient Cases	Cases	711	919	3,683	-	5,313	

Healthcare unit cost of each treatment provider is assumed as per the table below.

Table 9.2.6 Treatment Unit Cost by Type of Health Care Provider

Unit: VND

	Public Provider	Private Clinic	Self Treatment	Remarks
Outpatient Unit Cost	120,000	109,000	86,000	World Bank (2008) Adjusted for inflation. Medical and non-medical costs (e.g. transport) are included.
Inpatient Unit Cost	870,000	497,000	-	

Table 9.2.7 shows that the total estimated annual healthcare cost is VND 559 million.

Table 9.2.7 Health Care Cost Estimate

	Unit	Public Provider	Private Clinic	Self Treatment	Total
Outpatient Treatment Cases	Cases	711	919	3,683	5,313
Inpatient Treatment Cases	Cases	37	48	-	86
Outpatient Treatment Cost	VND million	85	100	317	502
Inpatient Treatment Cost	VND million	33	24	-	57
Total Cost	VND million	**118**	**124**	**317**	**559**

6 World Bank (2008) "Economic Impacts of Sanitation in Viet Nam"

Indirect Benefits

(c) Land value increase

It is considered that the project will improve the living environment and consequently property values in the project area will increase. A number of studies on similar projects in Viet Nam have estimated land value increase by 20%-35% to 10-15 times[7]. Property pricing or hedonic model cannot be used for the analysis due to the lack of available data on property market and the limited resources for data collection and processing. Referring to these previous studies on similar projects and interviews with local residents, it is assumed that there would be a moderate increase in land values of 3% over five years (15% increase in total) after the project becomes operational. Base land values are assumed on the basis of DNPPC's decision No.79/2010/QD-UNBD on the land unit prices in Dong Nai Province (Table 9.2.8).

Table 9.2.8 Land Value

Project Area	Land Area (ha)	Unit Value (VND million/m2)	Land Value (VND million)	3% Annual Increase	Government Land Prices in Area (VND million/m2)
Combined Sewer Area	272	9.0	24,480,000	734,400	Wards: Tanh Binh, Hoa Binh, Quyet Thang, Quang Vinh, Trung Dung Land Prices: 22.0 ~ 12.0 ~ 3.2 VND/m2
Separate Sewer Area	699	7.5	52,425,000	1,572,750	Wards: Thong Nhat, Tan Tien, Tan Mai, Tam Hiep Land Prices: 20.0 ~ 10.0 ~ 3.2 VND/m2
Total	971	-	76,905,000	2,307,150	

(d) Avoided fishery production loss

Fishery production in Bien Hoa City primarily relies on aquaculture in the Cai River. According to the Economic Department of Bien Hoa City PC, the city's fishery production was 2,850 tons in 2010. Its unit output value in 2011 price is estimated as VND 36.64 million/ton, or VND 32.97 million/ton in economic value[8]. Although river water quality improvement cannot be targeted as an effectiveness indicator for the project, the following assumptions are applied to quantify the project's benefit for the fishery production based on a previous study by the World Bank (2008):

- 40% of pollutant sources in Viet Nam's major rivers are from poor sanitation.
- In the southeast region (including the Dong Nai River basin), fishery production is estimated at 70% of the optimal level because dissolved oxygen levels are low (about 6 mg/l). Fishery production for other rivers with better water quality is estimated at 90% of the optimal level.
- It is assumed that the project will contribute to improving fishery production toward the 90% optimal level at least (i) 40% as pollutant sources and (ii) 22.7% as population coverage. Effects in downstream portions of Dong Nai River are excluded from the estimate due to its

7 For instance, JBIC (2006) "Study for Binh Duong Water Environment Improvement Project" estimates 5% increase of land value over six years.

8 According to the Dong Nai Statistical Yearbook 2009 (Dong Nai Statistical Office, 2010), the province's fishery production in 2009 is estimated at 35,928 tons with its output value at VND 1,062,320 million. The average output of VND 29.57 million/ton is adjusted by inflation and Standard Conversion Factor to acquire unit output value of VND 39.64 million/ton in 2011 financial price and VND 32.97 million/ton in economic price.

uncertainty.

Table 9.2.9 shows the estimated benefits for fishery output based on the assumptions above. Annual loss avoided by the project is estimated as VND 2,433 million.

Table 9.2.9 Avoided Fishery Production Loss

Unit: VND million

	Unit	Value	Remarks
Present production (2010)	tons	2,850	Economic Department, Bien Hoa City PC
Estimated output value	VND million	93,976	Unit output value: VND 32.97 million/ton
Output at 90% of optimal level	VND million	120,827	Present output is assumed as 70%
Present annual loss	VND million	26,850	
Service Ratio to City Population (2020)	-	22.7%	188,000 / 830,000
Pollution due to poor sanitation	-	40%	World Bank (2008)
Avoided annual loss	VND million	2,433	

(2) EIRR Calculation

The cash flow projection for the sewerage project component is presented in Table 9.2.10. The EIRR is 12.5%.

A sensitivity analysis is carried out to assess the change in EIRR for increases in capital and O&M costs. Results show that the EIRR is relatively sensitive to capital cost increases (See Table 9.2.11).

Table 9.2.10 Cash Flow Projection of Sewerage Component

Unit: VND million

Year	Cost				Benefit					Net Benefit
	Capital Expenditure	Reinvestment	O&M	Total	Avoided Sanitation Cost	Avoided Healthcare Cost	Land Value	Avoided Fishery Production Loss	Total	
2012	109,015	0	0	109,015	0	0	0	0	0	-109,015
2013	72,530	0	0	72,530	0	0	0	0	0	-72,530
2014	131,054	0	5,945	136,999	0	0	0	0	0	-136,999
2015	736,724	0	5,945	742,668	0	0	0	0	0	-742,668
2016	776,574	0	8,318	784,892	0	0	0	0	0	-784,892
2017	1,118,248	0	9,665	1,127,913	0	0	0	0	0	-1,127,913
2018	1,481,836	0	18,194	1,500,030	0	0	0	0	0	-1,500,030
2019	501,131	0	103,425	604,556	10,695	279	0	1,216	12,191	-592,365
2020	46,118	0	177,366	223,483	26,738	559	2,307,150	2,433	2,336,879	2,113,396
2021	0	0	192,151	192,151	26,738	559	2,307,150	2,433	2,336,879	2,144,728
2022	0	0	192,151	192,151	26,738	559	2,307,150	2,433	2,336,879	2,144,728
2023	0	0	192,151	192,151	26,738	559	2,307,150	2,433	2,336,879	2,144,728
2024	0	0	192,151	192,151	26,738	559	2,307,150	2,433	2,336,879	2,144,728
2025	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2026	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2027	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2028	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2029	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2030	0	116,709	192,151	308,860	26,738	559	0	2,433	29,729	-279,131
2031	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2032	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2033	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2034	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2035	0	1,083,461	192,151	1,275,611	26,738	559	0	2,433	29,729	-1,245,882
2036	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2037	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2038	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2039	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2040	0	116,709	192,151	308,860	26,738	559	0	2,433	29,729	-279,131
2041	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2042	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2043	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2044	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2045	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2046	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2047	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2048	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2049	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2050	0	1,200,170	192,151	1,392,321	26,738	559	0	2,433	29,729	-1,362,592
2051	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2052	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2053	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2054	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2055	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2056	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2057	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2058	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2059	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2060	0	116,709	192,151	308,860	26,738	559	0	2,433	29,729	-279,131
2061	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2062	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2063	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2064	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2065	0	1,083,461	192,151	1,275,611	26,738	559	0	2,433	29,729	-1,245,882
2066	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2067	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2068	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
2069	0	0	192,151	192,151	26,738	559	0	2,433	29,729	-162,422
Total	4,973,230	3,717,219	9,744,235	18,434,684	1,347,570	28,220	11,535,750	122,852	13,034,392	-5,400,293

EIRR	12.5%

Table 9.2.11 Sensitivity Analysis Results (Sewerage)

Base: 12.5%		Capital Cost + 0.0%	+ 2.5%	+ 5.0%	+ 7.5%	+ 10.0%
O&M Cost	+ 0.0%	12.5%	11.6%	10.7%	9.6%	*Below 8.0%*
	+ 2.5%	12.2%	11.4%	10.4%	9.1%	*Below 8.0%*
	+ 5.0%	12.0%	11.1%	10.0%	8.4%	*Below 8.0%*
	+ 7.5%	11.8%	10.8%	9.6%	*Below 8.0%*	*Below 8.0%*
	+ 10.0%	11.5%	10.5%	9.1%	*Below 8.0%*	*Below 8.0%*

9.2.4 Drainage Component

(1) Economic Benefit

The economic benefits quantified for the drainage project component are (i) property damage, (ii) residents' income loss and (iii) agricultural production loss to be avoided by the drainage and canal improvement. Since information is unavailable on the land use pattern during the project lifetime and the present flood damage (depth, frequency, duration and extent of damage) in the subject areas, the estimates are made based on the assumptions stated below.

(a) General assumptions

- The present flood affected areas to be mitigated by the project are 109.7 ha in the drainage project area and 130.1 ha in canal improvement areas.
- Flood depths and return periods are assumed as the table below:

Table 9.2.12 Flood Depths

Storm Return Period (Year)	0.20	1.00	5.00
Flood Depth (m)	0.10	0.20	0.60

- Land use pattern in the subject areas are assumed as the table below:

Table 9.2.13 Land Use Pattern

	Drainage Area	Canal Improvement Area
Residential Building Area Coverage	30%	15%
Other Services Building Area Coverage	5%	2%
Agricultural Production Area	0%	15%

(b) Property damage (buildings and movables)

Property damage avoided by the project is estimated based on the property values and damage rates. Table 9.2.14 and Table 9.2.15 illustrate assumptions followed to estimate the damage caused by floods in the subject area.

Table 9.2.14 Property Values

	Unit	Drainage Area	Canal Improvement Area	Remarks
Residential Building Unit Value	VND '000/m3	4,000	3,000	Assumed referring DNPPC housing unit price list (No.72/2008/QD-UBND)
Other Services Building Unit Value	VND '000/m3	5,000	4,000	
Movable value rate (Residential)	-	30%	30%	Percentage to building value
Movable value rate (Other services)	-	80%	80%	Percentage to building value
Estimated Building Values (Total)	VND million	1,590,650	689,530	Flood areas (ha) * Land use (%) * Unit values (VND)
Estimated Movable Values (Residential)	VND million	394,920	175,635	Building value (VND) * movable value rate (%)
Estimated Movable Values (Other Services)	VND million	219,400	83,264	Building value (VND) * movable value rate (%)

Table 9.2.15 Property Damage Estimation

	Unit	**0.1 m depth flood (0.2 year return)**	**0.2 m depth flood (1 year return)**	**0.6 m depth flood (5 year return)**	
Building Damage Rate *	-	0.0056	0.0062	0.0082	Damage rate = -0.0005x^2 + 0.0055x + 0.0051 where x = flood depth (m)
Damage Value (Drainage Area)	VND million	8,979	9,830	13,075	Building value (VND) * Damage rate (%)
Damage Value (Canal Improvement)	VND million	3,892	4,261	5,668	Building value (VND) * Damage rate (%)
Movables Damage Rate (Residential) *	-	0.0495	0.0530	0.0586	Damage rate = 0.0051Ln(x) + 0.0612 where x = flood depth (m)
Damage Value (Drainage Area)	VND million	19,531	20,928	23,140	Movable value (VND) * Damage rate (%)
Damage Value (Canal Improvement)	VND million	8,686	9,307	10,291	Movable value (VND) * Damage rate (%)
Movables Damage Rate (Other services) *	-	0.0387	0.0431	0.0431	Damage rate = 0.0063Ln(x) + 0.0532 where x = flood depth (m)
Damage Value (Drainage Area)	VND million	8,489	9,447	9,447	Movable value (VND) * Damage rate (%)
Damage Value (Canal Improvement)	VND million	3,222	3,585	3,585	Movable value (VND) * Damage rate (%)
Total Damage Value (Drainage Area)	VND million	**37,000**	**40,205**	**45,663**	
Total Damage Value (Canal Improvement)	VND million	**15,801**	**17,154**	**19,545**	

* Damage rate estimation formulae following JICA (1999) Ho Chi Minh Urban Drainage & Sewerage Project

(c) Income loss

Income loss due to inaccessibility and required cleaning/restoration works caused by floods are estimated based on unit household income, duration of suspended economic activities and affected household number. Following the assumptions described in Table 9.2.16, the avoided income loss is estimated as per Table 9.2.17.

Table 9.2.16 Assumptions on Income Loss Estimation

	Unit	Drainage Area	Canal Improvement Area	Remarks
Household Income (Economic Values)	VND/month	5,850,000	3,510,000	Drainage Area: VND 6.5 mil/mo (Willingness to pay survey), Canal Improvement Area: VND 3.9 mil/mo (low-income household by DNPPC)
Household Income per Day	VND/month	195,000	117,000	
Affected Households	Households	4,156	3,420	Flood area (ha) * 2020 population density by ward
Income Loss per Day	VND million/d	810	400	

Table 9.2.17 Income Loss Estimation

	Unit	0.1 m depth flood (0.2 year return)	0.2 m depth flood (1 year return)	0.6 m depth flood (5 year return)
Duration of Suspended Activities	days	1	1	5
Income Loss in Drainage Area	VND million	810	810	4,052
Income Loss in Canal Improvement Area	VND million	400	400	2,000

(d) Agricultural poduction loss

It is assumed that 15% of the canal improvement area is used for agricultural production and the value of its agricultural output is 52.36 million/ha[9] or VND 1,022 million in total. Table 9.2.18 shows the agricultural output loss estimation for each storm return period.

Table 9.2.18 Agricultural Output Loss

	Unit	0.1 m depth flood (0.2 year return)	0.2 m depth flood (1 year return)	0.6 m depth flood (5 year return)
Assumed Damage Rate	-	15%	15%	30%
Agricultural Output Loss in Canal Improvement Area (Annual Output: VND 1,022 million)	VND million	153	153	307

(e) Average annual loss

Average annual loss to be avoided by the project is VND 157,652 million in the drainage area and VND 83,032 million in the canal improvement area (See Table 9.2.19).

Table 9.2.19 Annual Average Loss

Unit: VND million

	Return Period of Avoidable Flood	Annual Probability	Probability Interval	Total Loss in Each Return Period	Average Loss	Average Annual Loss	Cummulative Average Annual Loss
Drainage Area	0.2	5.0	-	37,810	-	-	157,652
	1.0	1.0	4.0	41,016	39,413	157,652	
Canal Improvement Area	0.2	5.0	-	16,354	-	-	83,032
	1.0	1.0	4.0	17,707	17,031	68,122	
	5.0	0.2	0.8	21,852	18,638	14,910	

(2) EIRR Calculation

The cash flow projection for the drainage project component is presented in Table 9.2.20. The EIRR is 8.9%.

[9] According to the Dong Nai Province Statistical Yearbook (2009), agricultural output of Bien Hoa in 2009 was VND 126,446 million or VND 46.95 million/ha. The value is converted into VND 52.36 million in 2011 economic price by inflation rates and Standard Conversion Factor.

Table 9.2.20 Cash Flow Projection of Drainage Component

Unit: VND million

Year	Cost				Benefit			Net Benefit
	Capital Expenditure	Reinvestment	O&M	Total	Drainage Project Area	Canal Improvement Area	Total	
2012	0	0	0	0	0	0	0	0
2013	99,893	0	0	99,893	0	0	0	-99,893
2014	160,600	0	0	160,600	0	0	0	-160,600
2015	443,418	0	0	443,418	0	0	0	-443,418
2016	435,341	0	0	435,341	0	0	0	-435,341
2017	429,689	0	1,021	430,710	0	0	0	-430,710
2018	396,543	0	2,041	398,584	0	0	0	-398,584
2019	118,353	0	5,966	124,320	78,826	41,973	120,799	-3,521
2020	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2021	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2022	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2023	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2024	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2025	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2026	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2027	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2028	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2029	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2030	0	41,180	8,531	49,711	157,652	83,946	241,598	191,888
2031	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2032	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2033	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2034	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2035	0	2,899	8,531	11,430	157,652	83,946	241,598	230,168
2036	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2037	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2038	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2039	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2040	0	41,180	8,531	49,711	157,652	83,946	241,598	191,888
2041	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2042	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2043	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2044	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2045	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2046	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2047	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2048	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2049	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2050	0	44,079	8,531	52,610	157,652	83,946	241,598	188,989
2051	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2052	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2053	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2054	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2055	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2056	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2057	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2058	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2059	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2060	0	41,180	8,531	49,711	157,652	83,946	241,598	191,888
2061	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2062	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2063	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2064	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2065	0	2,899	8,531	11,430	157,652	83,946	241,598	230,168
2066	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2067	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2068	0	0	8,531	8,531	157,652	83,946	241,598	233,067
2069	0	0	8,531	8,531	157,652	83,946	241,598	233,067
Total	2,083,837	173,415	435,580	2,692,832	7,961,437	4,239,271	12,200,709	9,507,877

EIRR	8.9%

A sensitivity analysis is carried out to assess the change in the EIRR for increases in capital and O&M costs. Results show that the EIRR's is very sensitive to increases in capital costs. (See Table 9.2.21).

Table 9.2.21 Sensitivity Analysis Results (Drainage)

Base:		Capital Cost				
8.9%		+ 0%	+ 5%	+ 10%	+ 15%	+ 20%
O&M Cost	+ 0%	8.9%	8.5%	8.2%	7.9%	7.6%
	+ 5%	8.9%	8.5%	8.2%	7.8%	7.5%
	+ 10%	8.9%	8.5%	8.2%	7.8%	7.5%
	+ 15%	8.9%	8.5%	8.1%	7.8%	7.5%
	+ 20%	8.9%	8.5%	8.1%	7.8%	7.5%

CHAPTER 10 ENVIRONMENTAL CONSIDERATIONS

The objective of the impact assessment is to examine the environmental, physical, biological and social impacts in the areas which may be affected by the proposed project, and propose mitigation measures, as well as construction and operation environmental management and monitoring plans.

This project will contribute to the reduction of pollution and improved drainage. Benefits include improved public health and sanitation, and increased economic development. Downstream beneficiaries include a large population in Ho Chi Minh City that uses the Dong Nai River as a source of potable water. Limited adverse impacts generated by the project will be avoided or reduced to acceptable levels by appropriate mitigation measures. Resettlement of households affected by land acquisition will be appropriately compensated. The benefits significantly outweigh the limited negative impacts.

The EIA for the project was approved in 2009 by DNPPC. The EIA report was based on the components identified in the F/S Report for the “Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I up to the year 2010”. Proposed priority project I will implement the scope of work for a smaller priority area. The study team has confirmed that a supplemental EIA will not be required any approval because the location, scope, capacity and technology of the project components has not changed.

The following sections of the report provide background information on the provision of the EIA and a review of the EIA against JBIC guidelines for EIA. Report contents are summarized in Table 10.1.1.

Table 10.1.1 Section Summary

Items	Contents
Laws and Regulations	Laws and Regulations related to the EIA were studied. Main regulations are as follows: - Law No.52 / 2005 / QH11 (Law on Protection of the Environment) - Government Decree No. 80 / 2006 / ND-CP (Decree on the implementation of the Law on Protection of the Environment) - Decree No. 21/2008/ND-CP (Amendment and supplement of the Government Decree No.80/2006/ND-CP) - Circular No. 05/2008/TT-BTNMT (Guiding strategic environmental assessment, Environmental impact assessment and Environmental protection commitment)
Review of EIA	The status of current EIA prepared in 2008 was confirmed, and the JICA Study Team provides PMU with the necessary documents of the supplemental EIA. 1) The current EIA had been approved by the DNPPC on February 2009. EIA and RAP report should be divided. Detailed contents of RAP can be shown as “Section 11 Social Considerations”. 2) Executing organization, PMU is responsible to get approval from the DNPPC of the supplemental EIA in the case of a change in project contents. Detailed contents of the supplemental EIA were described in the main reports. 3) Considered “EIA Reports for Category A Projects” of the JBIC guideline. The current EIA was

Items	Contents
	checked by the JICA Study Team whether the contents were appropriate for the project. There are several shortcomings in the current EIA report so several countermeasures shall be made to complement the report and satisfy the JBIC guideline. 4) The EIA approval process consists of the "appraisal" and "approval". This is regarded as the approval process of EIA in Viet Nam. The supplemental EIA is almost the same. 5) Assistance for the supplemental EIA consists of the "1) Confirmation of the approval period" and "2) Support for the supplemental EIA document". The JICA Study Team confirmed that the supplemental EIA will not be required any approval by the DNPPC, based on the No. 762 UBND-CNN on 25th January 2011, and No. 63A BQLTN on 6th April 2011.
Current Condition	The current environmental condition is described at Chapter 3, and Chapter 11 (Social Considerations). EIA will be judged based on JBIC Guidelines as follows: 1) Screening Screening means the classification of the project into one of the categories A to C to be listed later. This project is found to be category A and the detailed process was described in the main report. 2) Environmental Impacts: Refer to Section 10.5 "Environmental Impacts" 3) Environmental Monitoring: : Refer to Section 10.6 "Environmental Monitoring"
Environmental Checklist	The environmental checklist is summarized, and described from physical, biological and socio-economic conditions, including all changes anticipated before the project commences. Additionally, it takes into account the current and proposed development activities within the project area but not directly connected to the project.
Environmental Impacts	The current EIA was confirmed to describe environmental impacts. There were a few serious impacts found. It predicts and assesses the project's likely positive and negative impacts, in quantitative terms to the extent possible. It identifies mitigation measures and any negative environmental impacts that cannot be mitigated, and explores opportunities for environmental enhancement.
Monitoring Plan	The current approved EIA was confirmed, but the "Monitoring" section needs to be reviewed based on the updated Viet Nam regulation Circular No. 05-2008-TT-BTNMT. At present, the detailed monitoring points can not be fixed and should be considered in the detailed design.

10.1 Laws and Regulations

There are some environmental regulations regarding Environmental Impact Assessment (EIA), the EIA approval process and related regulations, as shown in Table 10.1.2. Main characteristics of these regulations are as follows:

Table 10.1.2 Regulation List of EIA

Regulation Number	Characteristic
Law No.52 / 2005 / QH11	Law on Protection of the Environment (LEP) is issued by the National Assembly in Viet Nam. This is described as the basic policy of EIA in Viet Nam. Referring to this law, it is not possible for the project to be subject to EIA or a written commitment to protect the environment is enough.
Government Decree No. 80 / 2006 / ND-CP	It's a decree on the detailing and guiding the implementation of a number of articles of the LEP by National Assembly in Viet Nam. Pursuant to this decree, the types of EIA will be subject to followings: 1. Projects having risk of direct effects to water basin; 2. Projects on building urban infrastructure and residential areas; 3. Projects on building collective wastewater treatment system, design capacity 1,000 m^3/day or more.

Regulation Number	Characteristic
Decree No. 21/2008/ND-CP	It is issued by the Viet Nam Government on 28/02/2008, amending and supplementing some articles of the Government Decree No.80/2006/ND-CP dated 09/8/2006, and detailing and guiding the implementation of some articles on the LEP. Pursuant to this decree, the types of EIA will be subject to followings: 1. Projects having risk of direct effects to water basin; 2. Projects on building urban infrastructure, residential area with 50 hectares or more; 3. Projects on building underground works 4. Projects on building collective wastewater treatment system, design capacity 1,000 m^3/day or more;
Circular No. 05/2008/TT-BTNMT	It is issued by the Ministry of National Resource and Environment (MONRE) on 18/12/2008. It provides guidance Strategic Environmental Assessment (SEA), EIA and environmental protection commitment. From Appendix 4 to Annex 23 of this circular, the detailed provisions on the structure, content, component, application forms are specified for projects subject to EIA and supplementary report.

10.2 Review of EIA

10.2.1 Status of Current EIA

The status of the current EIA prepared in 2008 is shown in Table 10.2.1. This report was prepared by the Project Management Unit (PMU) under the Department of Construction of Dong Nai Province and submitted for appraisal by the Department of Natural Resources and Environment of Dong Nai Province (DONRE) in 2008. This report had been approved by DNPPC Decision No. 426 / QD-UBND (Appendix 10-A) on the 23rd of February 2009, according to the Appendix 2 of the Government Decree No. 80/2006/ND-CP. This EIA satisfies LEP, which is Article 20 of Law No.52/2005/QH11.

Table 10.2.1 Progress of the Current EIA

Contents	Target
EIA approval condition	The current EIA was appraised by DONRE of Dong Nai Province, and then had been approved by Dong Nai PC; refer to the Dong Nai Province Decision No. 426/QD-UBND, dated 23rd Feb 2009.
Applied project	Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I, up to the year 2010
Implementation contents during project period	- To implement precisely the contents of the EIA; - To comply with the approved Master Plan of Bien Hoa City - To comply with the Vietnamese construction standards and other relevant regulations about greenery area, and quarantine distance for sanitation; - To comply with the execution of environmental protection methods and ensure that treatment emission-gas, wastewater and solid waste to meet the Vietnamese environmental standards; - To abide by the regulations on providing information and reporting to authorities; - To coordinate closely with the local authorities on construction and operation periods to ensure security; - To raise awareness on environmental protection and labor-safety for workers during construction and operation periods; - To comply with the regulations about chemical safety, fire protection, incident response, labor safety, protecting water resources on construction and operation

Contents	Target
	periods; - To be allowed to be in operation after the project is inspected and certified by the authorities, ensuring that the project owner has completed the environmental protection commitments outlined in the EIA and with accompanying request for approval of EIA; - To bear all legal responsibilies for the occurrence of adverse effects and environmental incidents;
Implementation contents in terms of environmental & social consideration （Construction period）	- To organize the appropriated construction methods to minimize and prevent flood situations during the rainy season, that also cause traffic jams, landslide, damage to resident's houses and public structures; - To implement sanitary protection without affecting the landscape of the urban area, public health and traffic safety; - To ensure that dust, noise, vibration, odor and lighting do not exceed the permitted criteria; - To ensure that material transportation does not cause scattering, environmental pollution and traffic hazard; - To manage overall solid waste and wastewater to be generated at the site, and ensure that treatment of hazardous waste meets the relevant regulations in Viet Nam; - To minimize and prevent the scattering of lubricants
Implementation contents in terms of environmental & social consideration （Operation period）	- To construct a separate sewer system in order to comply with the detailed planning approved by the authorities; - To construct the drainage system and sewerage system in order to meet the Vietnamese environmental standards and relevant regulations; - To ensure that the discharge of STP does not cause flooding and avoid affecting the hydrological regime and environmental situation; - To arrange the outlets at propitious locations for authorities' inspection; - To install automatic monitoring systems on environmental quality at the output of the STP; - To manage and treat wastes-gas, sludge and hazardous sludge generated from the operation of STP in accordance with Vietnamese environmental standards and relevant regulations; - To prepare plans for preventing and responding to environmental incidents that occur during the operation of STP - To implement periodic environmental monitoring plan and manage monitoring data.
Valid period	The EIA will not expire the without any changes to project contents as discussed below
Revised EIA when the project is updated	In case of any modification to the project, the executing owner must prepare the revised EIA report which should include the updated parts of the projects.

Source: Dong Nai Province Decision No. 426 / QD-UBND

The current EIA was applied for the F/S Report on the "Project on Sewerage and Wastewater Treatment System for Bien Hoa City – Phase I up to the year 2010". However, the project will be carried out based on the review of F/S Report (JICA Phase I and II studies). Therefore, the executing organization, PMU, shall be responsible in obtaining approval of the supplemental EIA in case of change in location, scale, design output or technology under the following Vietnamese regulations in accordance with the supplemental EIA. It will take approximately one month for PMU to obtain approval from DNPPC, in case any supplemental EIA is required:

1) Clause 4 of Article 19 of LEP No. 52/2005/QH11
2) Clause 2 of Article 13 of Government Decree No. 80/2006/ND-CP
3) Clause 6 of Article 1 of Government Decree No. 21/2008/ND-CP

(Amendment of Government Decree No. 80/2006/ND-CP)

4) Paragraph 10 of Section 3 of Circular No. 05/2008/TT-BTNMT

The supplemental EIA shall contain the following items, according to Clause 2 of Article 13 of Government Decree No. 80/2006/ND-CP, and Clause 6 of Article 1 of Government Decree No. 21/2008/ND-CP:

1) Changes to the contents of the project;
2) Changes to the natural environmental status and to economic and social factors up until the time of preparation of the supplementary EIA report;
3) Changes to environmental impact and to measures for reducing negative impact;
4) Changes to the project's program for management and supervision of the environment;
5) Any other changes.

Detailed contents of the supplemental EIA as stipulated in paragraph 10 of Section 3 of Circular No. 05/2008/TT-BTNMT is shown below:

1. Project title
2. Project executing authority
3. Project geographical location (at the time of preparing the supplemental EIA)
4. Changes in project contents

4.1. Change location

4.2. Changes in scale, design capacity

4.3. Changes in production technology

4.4. Changes in raw material, fuel for production

4.5. Other changes

5. Changes in natural environmental status and socio-economic factors of the project area until the time of preparing the supplemental EIA
6. Changes in environmental impacts and mitigation measures of the project
7. Changes in the environmental management plan and monitoring program of the project
8. Other changes until the preparation of the supplemental EIA
9. Conclusion

It is noted that if there are no changes in project location, scope, capacity and technology, there will be no need for supplemental EIA. The JICA Study Team has confirmed that the supplemental EIA will not be required any approval by the DNPPC, based on No. 762 UBND-CNN (Appendix 10-B) dated 25th January 2011, and No. 63A BQLTN (Appendix 10-C) dated 6th April 2011. However, if the project implementation is carried out after 24 months from the date of approval of the EIA report, PMU must submit an explanation letter to concerned state agencies at the commencement of the project implementation, in accordance with the regulation in Item 6, Article. 1 of the Decree No. 21/2008/ND-CP, dated February 28, 2008.

10.2.2 Check of Contents of EIA Report according to JBIC Guideline

Table 10.2.2 shows the checklist of the contents of the EIA report according to "EIA Reports for Category A Projects" of the "Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations in April 2002, Japan Bank for International Cooperation, JBIC" (JBIC Guideline). The JICA Study Team verified whether the EIA contents were compatible with the JBIC guideline.

Table 10.2.2 Verification of Contents of the EIA Report against JBIC Requirement

JBIC Requirements	Check
EIA approval processes already exist in Viet Nam, and this project had been prepared considering the EIA reports.	○
Borrowers and related parties must officially complete the procedures and obtain approval from the government of the host country.	○
EIA reports must be written in the official language or a language widely used in the country where the project is to be implemented.	○
When explaining projects to local residents on matters such as involuntary resettlement, written materials must be provided in a language and form understandable to them.	1) RAP, in progress
Records and other documentation of such consultations on the above must be prepared	1) RAP, in progress
In preparing the EIA reports, consultation with stakeholders such as local residents, must take place after sufficient information has been disclosed.	1) RAP, in progress
EIA reports are required to be made available in the country and to the local residents where the project is to be implemented.	○
The EIA Report needs to cover the following items	
- Executive Summary (EIA Report Appendix: Relevant Documents – Vietnamese version only)	2) 3)Assist in preparation
- Policy, legal and administrative framework (EIA Report Preamble B, Page 2 – 11)	○
- Project description	○
- Baseline data (EIA Report Chapter 2, Page 54 – 101)	○
- Environmental impact and mitigation (EIA Report Chapter 3, Page 102 – 147 and Chapter 4, Page 148 – 147)	○
- Analysis of alternatives	4) Assist in preparation
- Environmental Management Plan, EMP (EIA Report Chapter 6, Page 169 – 175)	○
- Consultation (EIA Report Chapter 8, Page 181 – 182)	○

There are several deficiencies in the current EIA report. The following countermeasures shall be implemented to complement the current EIA report and to satisfy the JBIC guideline.

1) Resettlement Action Plan (hereinafter, RAP)

The EIA and RAP document should be divided based on the regulation of Viet Nam. Detailed contents and countermeasures are described in Chapter 11 - Social Considerations.

2) Appendix in English Version

Appendices were confirmed in the Vietnamese version. Their contents were prepared for translation to English by the JICA Study Team (Appendix 10-D). Said appendices are composed of the following:

1) Appendix 1: The related legal documents
2) Appendix 2: Comments of the communities in the project area
3) Appendix 3: Monitoring results for environment quality
4) Appendix 4: Drawings

3) Project Description

The project description needs to be modified if a supplemental EIA is required. The JICA Study Team is supposed to provide the detailed information to PMU. However, such detailed information is not necessary as supplemental EIA was not required for the project (refer to section 10.2.1).

4) Analysis of Alternatives

Phase I study (refer to Table 5.2.23, 5.2.24 of Phase I study report) had been carried out choosing the Phase II study area, by the comparative study of the multiple project area included in the terms of the environmental and social considerations. Additionally, the JICA Study Team analyzed the generated loads and discharged loads compared with current condition in 2010 and project completions in 2020 (refer to section 1.2.4, Figure1.2.5 Impact of Proposed Sewerage Projects on BOD load). This result could be assumed to a comparison of alternative plans included in zero option. Discharged loads will be decreased by the project. It's difference from the current condition and project completions in terms of water pollution, soil contamination, odor and resettlement in environmental and social considerations as follows.

1) Current condition (Zero option)

"Water pollution" was not changed such as BOD of over 300mg/l over in the phase I study, and serious issues are recognized in Bien Hoa City. Water environmental issues have been expanded with the bad influences caused by the waterborne diseases.

"Soil contamination" would need to be considered, if it were not changed in the current polluted water flow in Bien Hoa City.

"Offensive odor" won't be improved dramatically, it were not conducted by the sewerage project.

2) Project completions in 2020

"Water environmental", "Soil contamination", and "Offensive odor" in terms of environmental considerations will be improved by the project, and it's a positive impact that the bad influences caused by the waterborne diseases will be decreased.

By the way, "Involuntary resettlement" is difficult to avoid some parts of STP, PS and storm water by the project. However in case of STP area, it was applied for the principle and policy on resettlement implementation based on the Vietnam laws and regulations. JICA Study Team confirmed that STP area was decided to the following the perspective of technical point.

- STP No.1 area was selected without the involuntary resettlement, and STP No.2 area was selected the minimum involuntary resettlement compared with the alternative area.
- STP No.1 & No.2 area were selected to the lower area based on the sewerage plan in the actual study.

10.2.3 Approval Process of EIA

1) Appraisal

The EIA reports shall be evaluated by an appraisal council or services organization. The Ministry of Natural Resources and Environment (MONRE) shall provide regulations on the conditions and guidelines for appraisal of EIA. Related organizations above will be responsible for such appraisal. This process is based on: Article 21 of LEP, Law No.52/2005/QH11; Article 9, 11 and 12 of Government Decree No. 80/2006/ND-CP; and Clause 05 of Article 01 of Government Decree No. 21/2008/ND-CP.

2) Approval

Appraisal organizations shall be responsible for approving the EIA report after it has conducted its appraisal. Prior to approval, the organizations approving the EIA report shall consider petitions and recommendations from the project executing organization, the community involved, and other concerned organizations or individuals. This process is based on Article 22 of LEP, Law No.52/2005/QH11.

3) Responsibilities in Implementing the Contents of the EIA and in Inspecting its Implementation

The project executing organization shall have the following responsibilities:

- Report the contents of the decision on approval of the EIA report to the people's committee of the locality in which the project will be implemented.
- Display information publicly at the location where the project will be implemented, in order that the local community may know, inspect and supervise the same;
- Implement properly and fully the items of environmental protection in the EIA report and the requirements in the decision on approval of the EIA report;

- Notify on the performance of the items in the report and the requirements in the decision on the approval of the EIA report
- The project may be commissioned for use only after the executing organization has inspected and certified the performance of all requirements stipulated in the sub-clauses.

On the other hand, the appraisal organizations shall have the following responsibilities:

- Notify the items of its decision on the EIA approval to the provincial people's committee in the locality where the project will be implemented.
- Direct and organize inspection of the implementation of the items in the approved EIA. This process is based on Article 23 of LEP, Law No.52/2005/QH11, and Article 14, 15 and 16 of Government Decree No. 21/2008/ ND-CP.

Figure 10.2.1 shows the approval process of EIA in Viet Nam. Supplemental EIA approval process follows almost the same procedure.

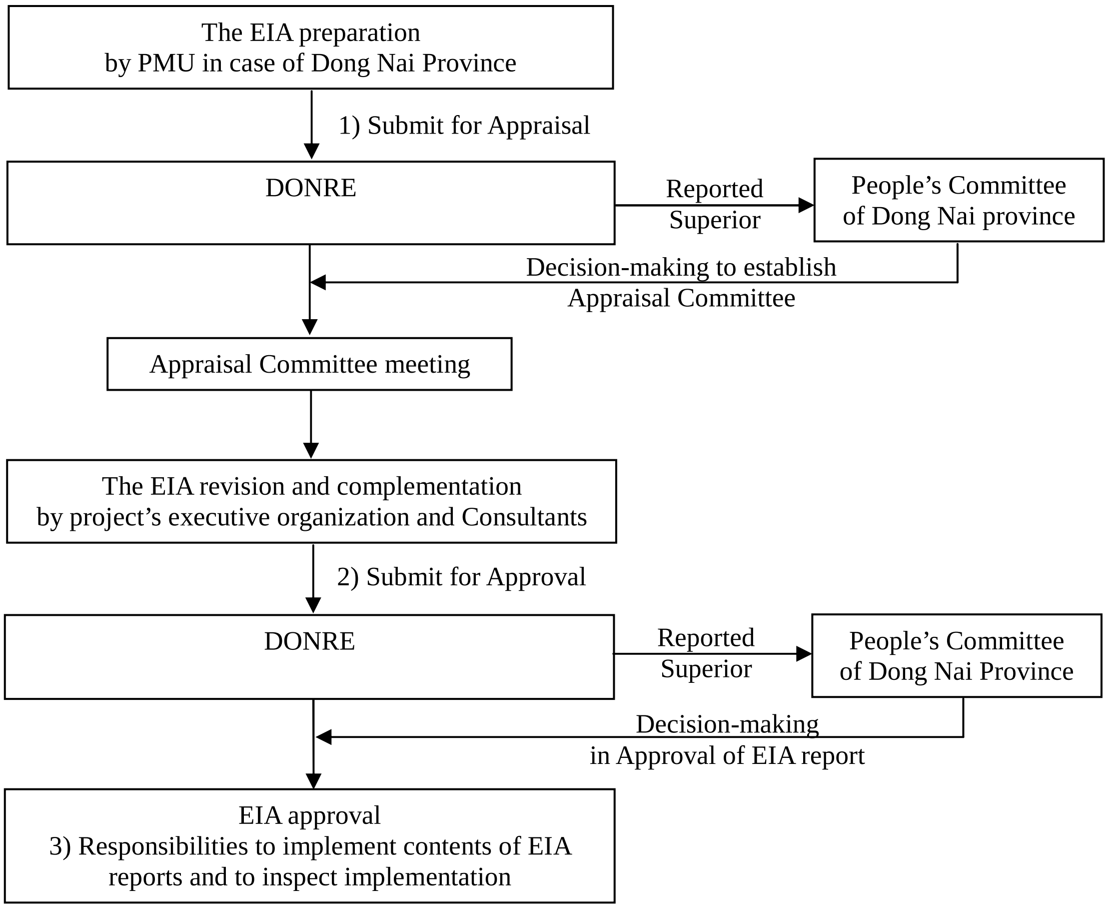


Figure 10.2.1 Approval Process for EIA

Necessary documents to be approved as the EIA and supplemental document are shown in Table 10.2.3.

Table 10.2.3 Necessary Documents for Approval

Documents	Check
1. EIA approval	
Official letter from the project owner requesting appraisal;	○
EIA report;	○
Feasibility study report or project investment report.	○
2. Supplementary EIA	
Official letter from the project owner requesting appraisal;	Not required
Supplementary EIA report;	Not required
Copies of Approved EIA report (Current EIA report);	Not required
Copies of the Decision Approving the current EIA report (with authentication);	Not required
Adjusted Feasibility Study report or Adjusted Project Investment report.	Not required

Source: Decree No. 80 / 2006 / ND-CP.

10.2.4 Assistance for Supplemental EIA Approval

There were several assistances for the necessary documents provided and confirmation of the PMU request, regarding the supplemental EIA approval. The contents of assistance are as follows:

1) Confirmation of the Approval Period of Supplemental EIA

If the project has any significant changes when compared with the F/S, PMU shall obtain a supplemental EIA approval from DNPPC. Supplemental EIA shall follow Circular No. 05/2008/TT-BTNMT. It is noted that it will take approximately one month to obtain such approval.

2) PMU Understanding of Supplemental EIA

The understanding on supplemental EIA by PMU is summarized as follows, based on letter No. 762/UBUD-CNN.

- In case the project, “Investment for Construction of Sewerage and Wastewater Treatment System for Bien Hoa City, Phase I”, has no change in terms of location, scope, capacity and technology compared with the approved EIA, PMU is not required to apply for extension of its validity.
- Same as above conditions, PMU is not required to prepare supplemental EIA, (however, they should submit an explanation letter to concerned state agencies during the commencement of the project implementation in accordance with the regulation in Item 6, Article 1 on Decree No. 21/2008/ND-CP).

3) Support for the Supplemental EIA Document

A checklist of project contents in EIA and the project (Appendix 10-E) shows how the project was reviewed or updated based on the approved EIA. The main points are shown as follows, and the JICA Study team has confirmed that the supplemental EIA will not be required any approval by the DNPPC.

- The JICA Study team provided “Calculation sheet of STP capacity 41,500 & 52,000 m^3/day”, “Sewer and drainage route map on current EIA and study team planning “ and “ Pumping Station No.1 Layout map” to PMU
- PMU judged that there shall be “no EIA changes” from “9.8 m x 14.8 m (approved EIA)” to “80 m x 80 m (the project)”, regarding the PS No.1 required area.
- PMU judged that there shall be “no EIA changes” from “Linh Bayou” to “Linh Bayou and stream” included in the additional Linh stream rehabilitation, regarding the additional Linh Stream.
- PMU judged that there shall be “no EIA changes” on the inclusion of “Bridge and Road construction”.

10.3 Current Condition

The current environmental condition is described in Chapter 3, while the social considerations are in Chapter 11. Based on the current conditions, EIA was judged by the JICA Study Team through the JBIC Guideline.

This JBIC guideline’s objective is to encourage project proponents in implementing appropriate environmental and social considerations in accordance with the guidelines. This is initiated by making clear the procedures (both before and after funding decisions are made), criteria for decision-making, and requirements on projects subject to funding. In so doing, JBIC endeavors to ensure transparency, predictability and accountability in its confirmation of environmental and social considerations. This detailed method is as follows:

1) Screening

“Screening” means classification of the project into one of the Categories A to C. Their characteristics are shown below:

- Category A: A proposed project is classified as Category A if it is likely to have significant adverse impact on the environment. A project with complicated impacts or unprecedented impacts which are difficult to assess is also classified under this category. This project belongs to this category based on influent possibilities of natural field (biological system, water quality and so on), and social field (transfer of religious institutions, inhabitant’s livelihood and so on).
- Category B: A proposed project is classified as Category B if its potential “environmental impact” is less adverse than that of Category A.
- Category C: A proposed project is classified as Category C if it is likely to have minimal or no adverse “environmental impact”.

The results of screening for the project are shown in Table 10.3.1. Present condition of each aspect was confirmed in the current EIA. However, there were no descriptions about the screening.

Based on the criteria and the screening of guideline considered for the current condition, "Category A" is applied to the first process of this project due to the following reasons:

- Natural environment and pollution will not be considered for the influent possibilities.
- Resettlement and land use in STP, PS and drainage pipeline areas will be considered as factors for influent possibilities.

Table 10.3.1 Checklist and Background of Environmental Screening

No	Environmental items	Rating	Remark
Social Environment			
1	Involuntary resettlement	A	Ref. Chapter 11
It is difficult to avoid some involuntary resettlement areas of STP, PS and storm water by the project, and thus detailed countermeasures for land acquisition and compensation is referred to in Chapter 11. The principle and policy on resettlement implemented by Bien Hoa City follows Viet Nam laws, and proper organization framework, and budget has been secured for compensation, resettlement and support to affected persons. Public consultation was conducted to inform project objectives, and land acquisition. However, further effective public consultation should be conducted in the coming month as measures to speed up resettlement activities.			
2	Local economy such as employment and livelihood, etc	C	Ref. Chapter 11
There are some positive impacts to ensure employment by the project, and sanitary conditions will be improved by the sewerage project.			
3	Land use and utilization of local resources	C	Ref. Chapter 11
The STP area will be changed from the ponds, regarding land use, but there will be few impacts. However, this factor needs to be considered not only during construction but also during operation.			
4	Social institutions such as social infrastructure and local decision-making institutions	D	
There are no existing social institutional issues in the project.			
5	Existing social infrastructures and services	D	
There are no existing social infrastructures and services issues in the project.			
6	The poor, indigenous and ethnic people	D	
There are no poor, indigenous and ethnic people in the project.			
7	Misdistribution of benefit and damage	D	
There are no misdistribution of benefit and damage issues in the project.			
8	Cultural heritage	D	
There is no cultural heritage located at the location of STP. At the pumping station, there is one grave that needs to be considered.			
9	Local conflict of interests	D	
There will be no conflict of interests related to the project, but there is a need to improve the water environment.			
10	Water Usage or Water Rights and Rights of Common	D	
There are water usage or water rights and rights of common issues involved in the project.			
11	Sanitation	D	
There are no sanitation issues during the conduct of the project.			
12	Hazards (Risk) related to infectious and diseases such as HIV/AIDS	D	
Ratio of infectious disease such as HIV/AIDS is rather low with approximately 0.29% of the total population of Bien Hoa City.			
13	Gender	D	

No	Environmental items	Rating	Remark
There are no gender issues in the project.			
Natural Environment			
14	Topographic and Geographical features	D	Ref. Section 3.1.2
The topographic and geographical characteristics were described in section 3.1.2. There are few environmental influences of this factor in the project.			
15	Soil Erosion	D	Ref. Section 3.1.2
There was no soil erosion that occurred in the project area as per section 3.1.2. Possibilities of this factor are few judging from the current condition of topographic characteristics.			
16	Groundwater (Underground facilities)	C	Ref. Section 3.1.4
Quantities of drinking water from wells are few as per section 3.1.4. However, there may be environmental influences caused by the embedded sewer, PS and STP construction. These factors need to be considered in the detailed design.			
17	Hydrological Situation	D	Ref. Section 3.1.4
The characteristics of hydrological situation are described in section 3.1.4. There are few environmental influences to the project due to this factor. Nevertheless, few impacts on water quality for the effluent from STP, and the detailed countermeasure are described in Item No. 24 below.			
18	Coastal Zone (Mangroves Coral reefs, Tidal flats, etc)	D	
There is no coastal zone in the project area.			
19	Flora, Fauna and Biodiversity	D	Ref. Section 3.4
The characteristics of flora, fauna and biodiversity are described at section 3.4. There are few environmental influences of this factor in the urban zone caused by the project.			
20	Meteorology	D	Ref. Section 3.1.3
The characteristics of meteorology are described in section 3.1.3. There are few environmental influences of this factor caused by the project.			
21	Landscape	C	Ref. Section 3.4
The characteristics of landscape are described at section 3.4. There may be environmental influences around the STP and PS facilities, and this factor needs to be considered after the project.			
22	Global Warming	C	Ref. Section 3.1.3
The trends of global warming are described in section 3.1.3. CO_2 gas will be temporarily increased due to heavy traffics during the construction and PS and STP operation. Taking into account the several possibilities of CO2 gas, this factor needs to be considered from the construction stage.			
Pollution			
23	Air pollution	C	Ref. Section 3.4
The trend of air pollution was described at section 3.4. There will be air pollution caused by the heavy traffic during construction, and this factor needs to be considered, especially in the construction stage.			
24	Water pollution	B	Ref. Section 3.1.4
The trend and related regulations of water pollution are described in section 3.1.4. Water pollution was confirmed such as BOD of over 300mg/l over in the phase I study, and serious issues were recognized in Bien Hoa City. Water environmental issues have been expanded with the bad influences caused by the waterborne diseases. Thus, appropriate countermeasures would be requested to be carried out by the government side as part of the water improvement projects, such as sewerage project.			
25	Soil contamination	C	Ref. Section 3.4
The trend of soil contamination was described in section 3.4. There may be soil contamination considered in the current polluted water flow in Bien Hoa City, and this factor needs to be considered from the construction stage.			
26	Waste	C	Ref. Section 3.4
The trend of waste is described in section 3.4. There will be many waste issues due to the construction scrap and surplus soil during the construction stage. This factor needs to be considered, including the method of waste treatment in the regulation.			

No	Environmental items	Rating	Remark
27	Noise and vibration	C	Ref. Section 3.4
The trend of noise and vibration is described in section 3.4. There will be noise and vibration issues caused by the use of machines during construction, and this factor needs to be considered during the construction stage.			
28	Ground Subsidence	D	Ref. Section 3.4
The trend of ground subsidence is described in section 3.4. There is few ground subsidence caused by the project, and considering that not much underground water were drawn.			
29	Offensive Odor	C	Ref. Section 3.4
The trend of offensive odor is described in section 3.4. There will be offensive odor issues due to the water pollution around the Dong Nai River, however related laws and regulations have been not existed yet. Nevertheless, it will be improved dramatically by the sewerage project, and this factor needs to be considered from the construction stage.			
30	Bottom sediment	C	Ref. Section 3.4
The trend of bottom sediment is described in section 3.4. There may be bottom sediment considered in the current polluted water flow in Bien Hoa City. This factor needs to be considered from the construction stage.			
31	Accident	C	
There will be some accidents with the use of construction machine during the construction and management of STP and PS after the project. This factor needs to be considered from the construction stage.			

<Rating>

A: Serious impact is expected, if any measure is not implemented to the impact.

B: Some impact is expected, if any measure is not implemented to the impact.

C: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)

D: No impact is expected. Therefore, EIA is not required.

2) Environmental Review

Environmental review means the review of environmental and social considerations when making a decision on funding, to confirm that requirements are duly satisfied. The projects that meet the requirements for environmental considerations stated in the guidelines will be confirmed in the following manner:

- Whether a project complies with environmental laws and standards of the host national and local governments concerned. (Refer to 10.5 Environmental Checklist and 10.6- Environmental Impacts)
- Whether it is following their environmental policies and plans (Refer to the section 10.1- Laws and Regulations)

Environmental considerations of the project have not substantially deviated from these standards.

3) Environmental Monitoring

Environmental monitoring consists of the monitoring and follow-up tasks, after the decision on funding have been made. This has been discussed in section "10.6 Monitoring Plan", which indicates that the project has not deviated from the standards.

DONRE will directly supervise the project executing organization, PMU, and the contractors carrying out the environmental and social considerations. The JICA Study Team proposed that

PMU hires an independent professional agency such as JICA, to conduct environmental monitoring for DONRE.

10.4 Environmental Checklist

This section is included in the environmental review. The environmental checklist shown in Table 10.4.1 describes the dimensions of the study area and relevant physical, biological and socio-economic conditions, including all changes anticipated before the project commences. Additionally, it takes into account the current and proposed development activities within the project area but not directly connected to the project. It indicates the need for any resettlement or social development plan, and includes a map showing the project site and the area affected.

Table 10.4.1 Environmental Checklist (1/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed?	① Yes, the current EIA was officially completed in October 2008 based on the F/S prepared by the Vietnam side. The JICA Study Team confirmed that the supplemental EIA will not be required any approval by the DNPPC.
		② Have EIA reports been approved by authorities of the host country's government?	② Yes, the current EIA was approved by Dong Nai PC in Feburary 2009. The JICA Study Team confirmed that the supplemental EIA will not be required any approval by the DNPPC.
		③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?	③ Yes, PMU must carry out the compensation and resettlement plans in accordance with the law in Vietnam. Therefore, RAP of related areas has already been prepared by the PMU.
		④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	④ Yes, the PMU needs to prepare the following necessary documents prior to obtaining environmental permissions from DONRE, before STP starts operating: 1) Certification that all commitments mentioned in EIA and all requirements imposed in the Approval Decision of EIA report have been completed by the project owner; (No.05-2008-TT-BTNMT) 2) Permission for discharging treatment water to the river (No.149-2004-ND-CP) 3) Level registers of hazardous waste, if any (No.02-2005-TT-BTNMT)
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public?	① Yes, public consultation for EIA was conducted by PMU in accordance with the LEP Law No. 52/2005/QH11, Decree No. 21/2008/ND-CP, Decree No. 80/2006/ND-CP, and No. 05/2008/TT-BTNMT. These contents are described in "Chapter 8 in EIA (P181-182)".
		② Are proper responses made to comments from the public and regulatory authorities?	② Yes, PMU has made proper responses to comments from the public and regulatory authorities. These processes were collected and compiled in "Appendix in EIA (Vietnam version only)". Therefore, the EIA was appraised and approved by DONRE and Dong Nai PC.
2 Mitigation Measures	(1) Water Quality	① Do pollutants, such as SS, BOD, COD, pH contained in treated effluent from a sewage treatment plant comply with the country's effluent standards?	① Yes, current water condition of the river in Bien Hoa City was confirmed to contain BOD of over 300mg/L based on water examiation, and several water-borne diseases based on the Phase I study. The water quality will be improved by the effluent from STP which complies with the Vietnam standards (Domestic wastewater QCVN 14:2008/BTNMT, refer to "section 4.5.2 Sewage Treatment Process ").

Table 10.4.1 Environmental Checklist (2/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
2 Mitigation Measures	(2) Wastes	① Are wastes, such as sludges generated by the facility operations properly treated and disposed of in accordance with the country's standards?	① Yes, the sludge from STP shall be treated and disposedto the landfill at a rate of 60 t/day after the dewatering process. Moreover, PMU had obtained approval of this process from DONRE, under the standard in Vietnam (Refer to "Chapter 1 in EIA, Page43)". Recently, the waste volume is so big, consequently making it continuously difficult to get hold of the disposal site. Thus, it needs to consider appropriate waste treatment.
	(3) Soil Contamination	① If wastes, such as sludges are suspected to contain heavy metals, are adequate measures taken to prevent contamination of soil and groundwater by leachates from the wastes?	① Yes, the current EIA confirmed that the influent to STP does not include heavy metal sludge, because industrial plants in Bien Hoa City constructed their STPs themselves (Refer to "section 3.3 Environmental Condition"). Meanwhile, heavy metals of the domestic part in Bien Hoa City are few, but craft and industrial production facilities partly need to be considered.
	(4) Noise and Vibration	① Do noise and vibrations generated from the facilities, such as sludge treatment facilities and pumping stations comply with the country's standards?	① Yes, the current EIA confirmed that the noise and vibration standard from the STP & PS facilities are as per Vietnam regulation, TCVN 7222:2002. The countermeasure is to install equipment (Refer to "section 10.5 Environmental Impact") that will serve as protection against noise and vibration from STP, PS and sewer.
	(5) Odor	① Are adequate control measures taken for odor sources, such as sludge treatment facilities?	① Yes, there is no current regulation in Vietnam related to odors from STP & PS facilities, but the deodorization countermeasure (Refer to "section 10.5 Environmental Impact") will provide protection against odor from STP and PS.
3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	① No, there are no protected areas in the project site.
	(2) Ecosystem	① Does the project site and discharge area encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? ④ Is there a possibility that the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	① No, there are no primeval forests, tropical rain forests and ecologically valuable habitats in the project site and discharge area. ② No, the project site and discharge area do not cover protected habitats of endangered species designated by the country's laws or international treaties and conventions . ③ No, there are no significant ecological impacts in the project site and discharge area. ④ No, there are no adversely affected aquatic environments in the project site and discharge area such as rivers .

Table 10.4.1 Environmental Checklist (3/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(1) Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?	① Yes, the project implementation shall cause involuntary resettlement. Yes, efforts will be made to minimize the impact caused by involuntary resettlement.
		② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement?	② Explanations on relocation and compensation have been given to affected persons through public meetings, notices on boards, and announcements through loudspeakers. Further public consultation will be implemented prior to resettlement.
		③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?	③ Bien Hoa PMU has been preparing the resettlement plan, including proper compensation, restoration of livelihoods and living standards. Socio-economic studies on resettlement will be implemented soon.
		④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?	④ Bien Hoa PMU has been preparing the resettlement plan, and it is expected that particular attention will be given to vulnerable groups or persons including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples.
		⑤ Are agreements with the affected persons obtained prior to resettlement?	⑤ Resettlement will be implemented after the preparation of RAP. PMU ensures that agreements with affected persons will be obtained prior to resettlement.
		⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?	⑥ PMU ensures that organizational framework will be established to properly implement resettlement. Capacity and budget will be secured to implement the plan.
		⑦ Is a plan developed to monitor the impacts of resettlement?	⑦ Bien Hoa PMU has been preparing the resettlement plan, including the monitoring and evaluation of impacts caused by resettlement.
	(2) Living and Livelihood	① Is there a possibility that changes in land uses and water uses due to the project will adversely affect the living conditions of inhabitants?	① No, there is no possibility that changes in land uses and water uses due to the project will adversely affect living conditions of inhabitants. There will be measures to ensure that Project-affected persons will be supported and compensated.
		② Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	② No, there is no possibility that the project will adversely affect the living conditions of inhabitants. Local authorities have policies and will consider necessary measures to reduce the impacts, if needed.

Table 10.4.1 Environmental Checklist (4/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(3) Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	① No, there is no possibility that the Project will damage local archeological, historical, cultural, and religious heritage sites.
	(4) Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	① No, there is no possibility that the project will adversely affect the local landscape.
	(5) Ethnic Minorities and Indigenous Peoples	① Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples? ② Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?	① There are no ethnic minorities and indigenous people in the project site. ② Not applicable in the project area.
5 Others	(1) Impacts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?	① Yes, adequate measures during construction are considered to reduce impacts caused by noise, vibrations, turbid water, dust, exhaust gases, and wastes. These detailed methods are described in "section 10.5 Environmental Impact". ② There are few natural environment (ecosystem) adversely affected by the construction activities . These detailed methods are described in "section 10.5 Environmental Impact". ③ There is no adverse effect to social environment due to the construction activities . ④ Yes, health and safety education such as traffic safety and public health are confirmed to be provided for project personnel, including workers. These detailed methods are described in "section 10.5 Environmental Impact".

Table 10.4.1 Environmental Checklist (5/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
5 Others	(2) Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?	① Yes, the current EIA was confirmed to include discussions for the implementation of monitoring program for environmental items that are considered to have potential impacts. These contents are described in "section 10.6 Monitoring Plan"
		② Are the items, methods and frequencies included in the monitoring program judged to be appropriate?	② Yes, the monitoring program is judged to be appropriate, but needs to be considered in the detailed design stage. These contents are described in "Chapter 6 in EIA (P169-175).
		③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?	③ Yes, an adequate monitoring framework is established. Its contents are described in "Chapter 7 in EIA (P176-180).
		④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	④ Yes, regulatory requirements pertaining to the monitoring report system are identified. These contents are described in "Chapter 6 in EIA (P169-175).
6 Note	Note on Using Environmental Checklist	① If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	① No, there are few environmental impacts caused by the project to transboundary or global issues such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality where it is located.

10.5 Environmental Impacts

This section is included in the environmental review. Environmental and social impacts are shown in Table 10.5.1, and it was confirmed that the current EIA describes similar contents as shown in the following table. Presently, there are only a few serious environmental impacts found in this study. However, the study predicts and assesses the project's likely positive and negative impacts, in quantitative terms to the extent possible. It identifies mitigation measures and any negative environmental impacts that cannot be mitigated, and explores opportunities for environmental enhancement. It identifies and estimates the extent and quality of available data, essential data gaps and uncertainties associated with the predictions, and specifies topics that do not require further attention.

Table 10.5.1 Environmental Impacts and Mitigation Measures

Contents	Impacts	Mitigation Measures
A. Current Condition		
1. Water Pollution		
Domestic wastewater flowed in Bien Hoa	There are several impacts in the sanitary fields, such as the dysenteric diarrheas and dysenteries. Current condition is discussed in section 3.6.	STP No.2 will be collected and treated approximate 19.25t /day polluted sources (refer to Appendix 4-B-4) by the project. The number of dysenteric diarrheas and dysenteries in the sanitary field will be improved after the project, and the total polluted source needs to be more decreased through environmental awareness and instruction initiated by the government.
Run-off stormwater	Water environmental impacts will be predicted from the extent of several polluted sources, if stormwater drainage will not be constructed. The current water quality is described in section 3.1.4.	STP No.2 will be collected and treated approximate 19.25t /day polluted sources (refer to Appendix 4-B-4) by the project. The water quality due to run-off stormwater will be improved after the project, and the total polluted source needs to be more decreased through environmental awareness and instruction initiated by the government.
Sludge from streams, canals and sewers	There are water environmental impacts caused by heavy metal pollution, which is included in sludge with domestic and industrial wastewater flow. The current water quality is described in section 3.1.4.	STP No.2 will be collected and treated approximate 19.25t /day polluted sources (refer to Appendix 4-B-4) by the project. The water quality of the sludge from streams, canal and sewers will be improved after the project, and the total polluted source needs to be more decreased through environmental awareness and instruction initiated by the government.
2. Soil Contamination		
Sludge from streams, canals and sewers	There are the environmental impacts in the underground due to heavy metal pollution, included in sludge with domestic and industrial wastewater flow by the stream, canal and sewers. The current soil contamination is described in section 3.4.	STP No.2 will be collected and treated approximate 19.25t /day polluted sources (refer to Appendix 4-B-4) by the project. The soil contamination by the sludge from the stream, canal and sewers will be improved after the project, and the total polluted source needs to be more decreased through the

Contents	Impacts	Mitigation Measures
		environmental awareness and instruction initiated by the government.
3. Waste		
Sludge from the stream, canal and sewers	There are environmental impacts in the sanitary field if polluted sources with heavy metals are not treated. The current condition of waste is described in section 3.4.	STP No.2 will be collected and treated approximate 19.25t /day polluted sources (refer to Appendix 4-B-4) by the project. The waste with the pollution sources will be improved after the project, and the total waste needs to be more decreased through environmental awareness and instruction initiated by the government.
4. Odor		
Bad smell	There is no regulation in Viet Nam related to countermeasure against odor. Thus this will have environmental impacts in the residential area around the STP facilities, or along the current river contaminated with domestic and industrial waste including heavy metals.	The deodorization facilities to be prepared in the STP & PS facilities will mitigate odor pollution in the residential area. These facilities are designed with activated carbon adsorption systems to protect residents from bad smells (refer to Section 4.5.3 (4) and 5.2.2 (2) 4)). The odor along the current river with domestic and industrial waste including heavy metals will be improved after the project, while the total polluted source needs to be more decreased through the environmental awareness and instruction initiated by the government.
5. Bottom sediment		
Sludge from streams, canals and sewers	There are the environmental impacts in the underground due to heavy metal pollution included in sludge with domestic and industrial wastewater flow by the stream, canal and sewers. The current soil contamination is discussed in section 3.4.	STP No.2 will be collected and treated approximate 19.25t /day polluted sources (refer to Appendix 4-B-4) by the project. The soil contamination by the sludge from the stream, canal and sewers will be improved after the project, and the total polluted source needs to be more decreased through environmental awareness and instruction initiated by the government.
B. Construction Period		
1.Groundwater		
Pollution of the groundwater	There are several impacts in the sanitary fields, such as dysenteric diarrheas and dysenteries, due to groundwater use from polluted source during the sewer, PS and STP open cut method construction.	The total volume of groundwater is limited; therefore there is few impact in this field but the consideration for use of groundwater should be promoted through environmental awareness and instruction initiated by the government.
2. Global Warming		
Contents: Increase of the CO_2 gas	CO_2 gas emission will increase due to operation of cranes, bulldozers, etc, during construction stage.	CO_2 gas emission will be mitigated during construction period if countermeasure for construction machines is appropriate. The executing agency (PMU) needs to prepare the standard of construction machine, guide the contractor in this matter, and consider CO_2 gas pollution monitoring in the Environmental Management Program (EMP).

Contents	Impacts	Mitigation Measures
3. Air Pollution		
Increase of the dust	Dust will increase due to operations of cranes, bulldozers, etc., during construction stage, which will also cause several impacts in the sanitary field.	Dust emission will be mitigated during the construction period if countermeasure for construction machines is appropriate. The executing agency (PMU) needs to prepare the standard of construction machine, guide the contractor in this matter, and consider air pollution monitoring in the EMP.
4. Water Pollution		
Same as "A. Current Construction"	Same as "A. Current Construction"	1) Same as "A. Current Construction" 2) The executing agency (PMU) needs to consider water quality monitoring in the EMP.
5. Soil Contamination		
Sludge from the stream, canal and sewers	Same as "A. Current Construction"	1) Same as "A. Current Construction" 2) The executing agency (PMU) needs to consider soil quality monitoring in the EMP.
Detection of the polluted sources by the construction	The polluted sources will be detected from the polluted water during the construction period, Such sources have several impacts in the sanitary field.	The polluted sources will be mitigated during the construction period if the countermeasure for polluted soil is appropriate. The executing agency (PMU) needs to prepare the standard of construction machine, guide the contractor in this matter.
6. Waste		
Sludge from the stream, canal, sewers	Same as "A. Current Construction"	Same as "A. Current Construction"
Debris of construction activities	There will be several impacts in the sanitary field, especially the residential area around the STP.	Debris from construction activities will be mitigated if the countermeasure is conducted with appropriate treatment. The executing agency (PMU) needs to prepare the standard of construction machine, guide the contractor in this matter.
7. Noise & Vibration		
Contents: Noise & Vibration from the construction machines	Noise and vibration will be increased with the operation of crane, bulldozer etc during the construction stage, which will also cause several impacts in the environmental field.	Noise and vibration will be mitigated if the countermeasure for construction machine is appropriate. The executing agency (PMU) needs to prepare the standard of construction machine, guide the contractor in this matter, and consider noise and vibration monitoring in the EMP.
8. Odor		
Odor in construction site	There will be environmental impacts to the residential areas due to odor from polluted water, waste, soil contamination and dust.	The deodorization facilities which will be prepared in the STP & PS facilities will mitigate odor pollution in the residential area around these facilities. These facilities are designed with activated carbon adsorption systems to protect residents from bad smells (refer to Section 4.5.3 (4) and 5.2.2 (2) 4)). The executing agency (PMU) needs to

Contents	Impacts	Mitigation Measures
		consider odor monitoring in the EMP.
9. Bottom sediment		
Sludge from the stream, canal and sewers	Same as "A. Current Construction"	1) Same as "A. Current Construction" 2) The executing agency (PMU) needs to consider bottom sediment monitoring in the EMP.
Bottom sediment in lake	There will be several impacts in the sanitary field due to the bottom sediment in the lake in Bien Hoa City.	The polluted sources will be mitigated during the construction period if the countermeasure for polluted water is appropriate. The executing agency (PMU) needs to prepare the standard of construction machine, and guide the contractor in this matter.
10. Accident		
Contents: Accident in construction period	Some accidents may occur during the construction period.	There will be few impacts from accidents if the countermeasure for construction security method is appropriate. The contractor needs to consider the security manual and appropriate construction management.
C. Operation Period		
1.Landscape		
Consideration of the landscape around the new buildings	There will be few environmental impacts, and some effects to the landscape around the new PS and STP.	The executing agency (PMU) needs to consider Landscape monitoring in the EMP.
2. Global Warming		
Increase of CO_2 gas	There may be the environmental impacts caused by the CO_2 gas with the operation of STP.	The executing agency (PMU) needs to consider CO_2 gas pollution monitoring in the EMP.
3. Air Pollution		
Increase of the dust	There will be few environmental impacts due to air pollution after construction.	The executing agency (PMU) needs to consider air pollution monitoring in the EMP.
4. Water Pollution		
Domestic wastewater flowed in Bien Hoa	The water environment, with the domestic and industrial wastewater flow, will be improved by the project, leading to few impacts in the sanitary field, such as outbreak of dysenteric diarrheas and dysenteries.	The executing agency (PMU) needs to consider water quality monitoring in the EMP.
Run-off stormwater	The water environment, with the polluted source with domestic and industrial water, will be improved by the project leading to few impacts in the sanitary field.	The executing agency (PMU) needs to consider water quality monitoring in the EMP.
Sludge from streams, canal and sewers	The water environment, whose source is polluted with domestic and industrial water, will be improved by the project leading to few impacts in the sanitary field.	The executing agency (PMU) needs to consider water quality monitoring in the EMP.

Contents	Impacts	Mitigation Measures
5. Soil Contamination		
Sludge from streams, canal and sewers	The water environment, with heavy metals pollution included in sludge, will be improved by the project leading to few impacts in the sanitary field.	The executing agency (PMU) needs to consider detection of polluted sources by monitoring the soil in the EMP.
6. Waste		
Sludge from streams, canals and STP	There will be few environmental improvements in the sanitary in terms of sludge from the stream, canal and STP.	The executing agency (PMU) needs to consider monitoring of the residential area in terms of sanitary situation in the EMP.
7. Noise & Vibration		
Operation machines in PS and STP	There will be few environmental impacts to residence areas caused by noise and vibration in and around the PS and STP after the construction period.	The executing agency (PMU) needs to consider noise and vibration monitoring in the EMP.
8. Odor		
Operation machines in PS and STP	There will be few environmental impacts to residential areas caused by odor in and around the STP and the stream within the project.	The executing agency (PMU) needs to consider odor monitoring in the EMP.
9. Bottom sediment		
Bottom sediment in lake	The water environment, with heavy metal pollution included in sludge, will be improved by the project leading to few impacts in the sanitary field.	The executing agency (PMU) needs to consider detection of polluted sources by monitoring the soil in the EMP.

10.6 Monitoring Plan

Monitoring plan will be conducted to the Environmental Management Program (EMP) in the Construction and Operation period of the project. It was confirmed in the currently approved EIA that the approximate contents at that time it was conducted were discussed. However, the monitoring aspects in this section were reviewed based on the updated Viet Nam regulation Circular No. 05-2008-TT-BTNMT, and draft monitoring plan are shown in Table 10.6.1. In the current condition, the detailed monitoring points can not be fixed and should be considered in the detailed design. Actual monitoring results in other projects and latest regulations in Viet Nam should also be considered. Figure 10.6.1 shows the draft monitoring points. Draft monitoring plan is described at item, frequency, method and period. The standard of the monitoring item will be applied for the Vietnam regulation.

Basically, executive organization, PMU will assist and request the contractor to conduct works required as part of environmental considerations during the construction stage. SDCO (Operation Company) conducts works required as part of environmental considerations during operation stage. Monitoring plan will be outsourced to the environmental organization related to the DONRE, refer to the actual results in Vietnam.

Table 10.6.1 Draft Monitoring Plan

Items		Implementation Schedule
Monitoring Period: from Construction period to Operation Period		
1.Landscape	Monitoring point	Part of 1) and 2) as “4. Water pollution”
	Monitoring items	Landscape of residence area around STP and PS
	Measurement frequency	Two times/year
	Monitoring method	Hearing from the residence area
2. Global Warming	Monitoring point	Same as “4. Water pollution”
	Monitoring items	CO_2 gas
	Measurement frequency & period	Two times/year
	Monitoring method	Applied for the Vietnam regulation
3. Air Pollution	Monitoring point	Same as “4. Water pollution”
	Monitoring items	Suspended dust, Temperature, Humidification, Atmospheric pressure, Wind-speed and direction SO_2; NO_2; CO; NH_3; H_2S; CH_4;
	Measurement frequency	Two times/year
	Monitoring method	Applied for the Vietnam regulation
4. Water Pollution	Monitoring point	Constant water examination has been conducted on several points of Bien Hoa by PMU in the Phase I study (Refer to Figure 3.2.3 P3-25 in the Phase I study report). Monitoring plan for the water pollution field will be considered in the current results, and proposed on alternative points which are related to the project as follows: 1) STP No.2 (Influent and effluent points on Linh stream) x 2 points 2) PS No. 1 x 2 points 3) Sewerage x 3 points (One is a the effluent points to the Dong Nai River on a combined area, and the other is a separated area)
	Monitoring items	pH; BOD_5; COD; DO; SS; NH_4+; NO_3-; NO_2-; $SO_4$2-; Cl-; F-; Fe; Pb; Zn; Cd; Hg; As; Phenol (total); CN-; Total oils and grease; E.Coli; Total Coliform.
	Measurement frequency	Four times/year
	Monitoring method	Applied for the Vietnam regulation
5. Soil Contamination	Monitoring point	Same as “4. Water pollution”
	Monitoring items	As; Hg; Cr; Zn; Cu; Cd; oils
	Measurement frequency	Four times/year
	Monitoring method	Applied for the Vietnam regulation
6. Waste	Monitoring point	Disposal Site
	Monitoring items	Waste Volume
	Measurement frequency	Four times/year

Items		Implementation Schedule
	Monitoring method	Applied for the Vietnam regulation
7. Noise & Vibration	Monitoring point	Same as “4. Water pollution”
	Monitoring items	Noise; Vibration;
	Measurement frequency	Two times/year
	Monitoring method	Applied for the Vietnam regulation
8. Odor	Monitoring point	Same as “4. Water pollution”
	Monitoring items	The odor
	Measurement frequency	Two times/year
	Monitoring method	Applied for the Vietnam regulation
9. Bottom sediment	Monitoring point	Several points of the lake in the study area
	Monitoring items	As; Hg; Cr; Zn; Cu; Cd; Oils
	Measurement frequency	Four times/year
	Monitoring method	Applied for the Vietnam regulation

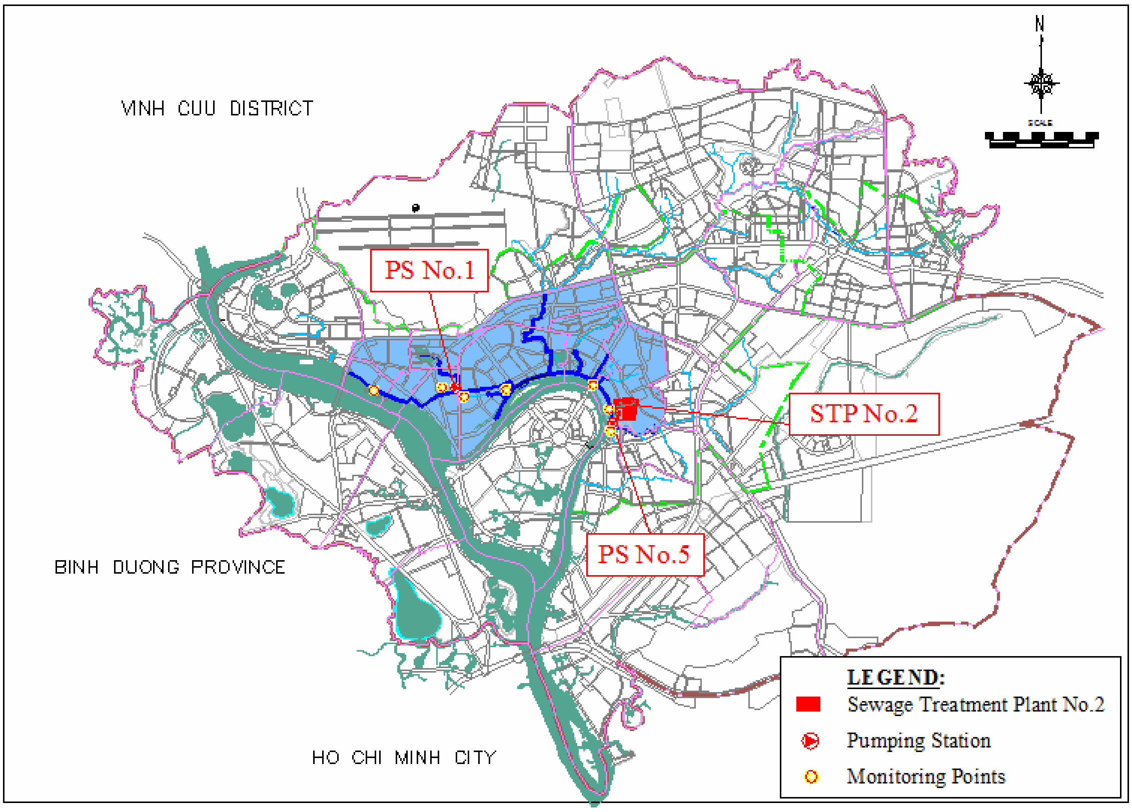


Figure 10.6.1 Proposed Monitoring Points

Table 10.6.2 shows the breakdown of total monitoring cost per year, and this is included in the administration cost of non eligible portion in the Chapter 8 cost estimate. Quantities can be calculated based on the proposed monitoring plan shown in Table 10.6.1, while the unit prices can be derived from the current EIA (Refer to the Chapter 7 of the current EIA report).

Table 10.6.2 Total Cost Estimate for the Monitoring Plan

No	Contents	Qty	Price (VND)	Cost (VND)
1.	Construction Period			
1)	Air pollution			
	SO_2	14	300,000	4,200,000
	NO_2	14	300,000	4,200,000
	CO	14	300,000	4,200,000
	NH_3	14	300,000	4,200,000
	H_2S	14	300,000	4,200,000
	CH_4	14	300,000	4,200,000
2)	Water Pollution			
	pH	28	30,000	840,000
	BOD_5	28	80,000	2,240,000
	COD	28	70,000	1,960,000
	DO	28	60,000	1,680,000
	SS	28	50,000	1,400,000
	NH_4+	28	60,000*	1,680,000
	NO_3-	28	50,000	1,400,000
	NO_2-	28	50,000	1,400,000
	SO_4^{2-}	28	50,000	1,400,000
	Cl-	28	50,000	1,400,000
	F-	28	60,000*	1,680,000
	Fe	28	60,000	1,680,000
	Pb	28	60,000	1,680,000
	Zn	28	60,000	1,680,000
	Cd	28	60,000	1,680,000
	Hg	28	80,000	2,240,000
	As	28	60,000	1,680,000
	Phenol (total)	28	60,000*	1,680,000
	CN-	28	60,000*	1,680,000
	Total Oils & grease;	28	300,000	8,400,000
	E.Coli	28	60,000	1,680,000
	Total Coliform.	28	60,000	1,680,000
3)	Soil Contamination			
	As	28	300,000	8,400,000
	Hg	28	300,000	8,400,000
	Cr	28	300,000	8,400,000
	Zn	28	300,000	8,400,000
	Cu	28	300,000	8,400,000
	Cd	28	300,000	8,400,000
	Oils	28	300,000	8,400,000
4)	Noise & Vibration			
	Noise	14	70,000	980,000
	Vibration	14	40,000	560,000
5)	Odor	14	300,000*	4,200,000
6)	Bottom Sediment			
	As	28	300,000	8,400,000
	Hg	28	300,000	8,400,000
	Cr	28	300,000	8,400,000

No	Contents	Qty	Price (VND)	Cost (VND)
	Zn	28	300,000	8,400,000
	Cu	28	300,000	8,400,000
	Cd	28	300,000	8,400,000
	Oils	28	300,000	8,400,000
	Total 1) – 6)			191,380,000
	Escalation from 2008 to 2011 (Background of the cost estimate)		20%	38,276,000
	Total Cost Estimate			229,656,000

* No background data, but it will be assumed based on other related measurement items

CHAPTER 11 SOCIAL CONSIDERATIONS

11.1 Approach and Methodology for Social Considerations

This JICA Preparatory Study formulates the scope and examines the viability of the Dong Nai Environmental Improvement Project (sewerage and drainage). Obviously, with improved sewerage and drainage infrastructures, the city not only will improve its public health conditions but also will be able to attract investments for industrial and commercial activities. All these factors will contribute direct benefits to the living standards, income levels and overall social texture.

However, similar to many other large infrastructure projects, this Project is also expected to require land acquisition and involuntary resettlement. So it is important to ensure that proper compensation is paid to the Project Affected Persons (PAP) and Displaced Persons (DP) so that living conditions of these people do not deteriorate. It is universally accepted that a Resettlement Action Plan (RAP) is the best instrument to implement a successful resettlement program.

In the Vietnamese regulations the terminology used for the RAP is Compensation, Support and Resettlement Plan (CSRP). The RAP framework document prepared by the PMU was submitted to DNPPC for approval in February, 2011 (Letter 33/BQLTN, 28th February, 2011). Field activities for compensation planning for the proposed Sewerage Treatment Plant (STP2) site was started in August 2010 (BH CPC letter 2333/UBND-XDCB, dated 18 August, 2010) and is now being continued by the PMU and the Center for Land Development (CLD), an agency attached with Bien Hoa CPC. It is expected that field activities for the other components would start in the second quarter of 2011.

RAP preparation and execution is the sole responsibility of the Vietnamese side. The JICA Study Team provides advice and support so that the RAP preparation can be prepared in a timely manner complying a holistic 'best practice' approach. In this regard, the JICA Study Team carried out the following activities;

- Review Vietnamese relevant laws;
- Assess the gap between Vietnamese laws and international norms;
- Recommend best practice policy;
- Assess the socioeconomic situation of the PAP and DP;
- Compile lessons learned from similar projects in Viet Nam;
- Conduct consultation with PAP to obtain their view on resettlement process;
- Visit relocation options;
- Recommend on the RAP preparation and implementation; and

- Review and comment on the ongoing RAP preparation.

11.2 Scope of Land Acquisition and Resettlement

Not all components of the Project require land acquisition and resettlement. The components of the Project and the scope of land acquisition and resettlement are shown in Table 11.2.1. The construction of the STP2, pumping station and canal improvements require permanent land acquisitions resulting in involuntary resettlement.

Table 11.2.1 Scope of Land Acquisition and Resettlement

Project Components	Description	Land Acquisition	Resettlement
STP2 at Tam Hiep	Capacity: 52,000 m^3/d	YES. Area required: 9.342 ha	YES
Pumping Station at Thong Nhat (PS1)	Capacity: 11,400 m^3/d (daily average dry weather)	YES. Area required: 80 m × 80 m	YES
Pumping Station at the STP (PS5)	Capacity: 52,000 m^3/d (daily average wet weather)	NO. Included in STP site	N/A
Manhole type pump station	Total : 25	Public land	N/A
Main Trunk Sewer	Length: 12 km	Public land	N/A
Branch Sewer	Length: 42 km	Public land	N/A
Tertiary Sewer	Length: 203 km	Public land	N/A
House connections	Total : 28,700	N/A	N/A
Interceptor pipe	Length: 6 km	Public land	N/A
Overflow chamber	Total : 22	Public land	N/A
Storm water main pipe	Length: 45 km	Public land	N/A
Storm water brunch pipe	Length: 111 km	Public land	N/A
Combined sewer	Length: 10 km	Public land	N/A
Canal improvement: Dien Hong	Length: 0.37 km	YES. Area required: TBD	TBD
Canal improvement: San Mau	Length: 9.16 km	YES. Area required: TBD	TBD
Canal improvement: Linh Bayou	Length: 2.21 km	YES. Area required: TBD	TBD
Canal improvement: Linh stream	Length: 1.15 km	Already completed*	N/A

Note: N/A: Not applicable, TBD: To be determined.
* = Status is investigated and reported in Section 11.4.5.

It is estimated preliminarily that the total affected households will be more than 1,100 for the implementation of this Project. Out of that, for around 900 cases, it will be partial acquisition while the rest will be complete acquisition. It is estimated that in the STP2 area, about 88 households will be affected, of which land of 75 households will be fully acquired and land of 13 households will be partially acquired. Although the total impacts are more extensive for the PS1 and canal improvement, there will be fewer cases of complete acquisition. (RAP Framework Report prepared by PMU, Feb, 2011)

The location of the STP2 site at living quarter (LQ) No. 2, Tam Hiep Ward has been authorized by DNPPC Decision No. 4507/QD-UBND dated 21 December, 2007. For the construction of the

STP2, total allocated land for the Project is 93,087.2 m^2, of which: (i) 22,588.7 m^2 is residential land; (ii) 7,047.8 m^2 is farm land; (iii) 56,195.3 m^2 is aquaculture land; (iv) 942.3 m^2 is transportation land; (v) 6,281 m^2 is irrigation land and (vi) 32 m^2 is river, stream and channel land.

For PS1, about 6,400 m^2 is proposed at living quarter LQ-6 of Thong Nhat Ward according to document No. 49/BQLTN dated 28 December 2004, sent to the Division of Urban Management of Bien Hoa City by the PMU. After the introduction of Decree No. 69/2009, unlike the case for STP2 site (i.e., issuing a land use authorization), it is only required that BH CPC issue a notice of land acquisition. According to PMU, such notice for PS1 site is expected to be issued within April 2011.

The land acquisition process for canal improvement is expected to start at the same time as the activities for PS1. According to letter 41/BQLTN, dated 17 March, 2011, the land requirements for the canal improvement are 137,400 m^2 for San Mau, 24,400 m^2 for Linh Bayou, and 21,700 m^2 for Dien Hong stream.

11.3 Laws, Regulations, Guidelines and Policies

11.3.1 Relevant Vietnamese Legislation

Prior to 2004, Vietnamese laws and regulations were not specific on the process for the land acquisition, involuntary resettlement and relevant support and compensation. As a result, these activities had never been smooth before 2004. Land Law 13/2003 is the comprehensive land administration law which became effective since 2004. The Presidential Order 26/2003 stipulates compensation and relocation of people affected by land clearance for investment projects. Decree No. 197/2004 is the first systematic law for land acquisition and resettlement process. Later, Decree No. 17/2006, Decree No. 69/2009 and their amendments further streamlined the land acquisition and resettlement procedure. Decree No. 123/2007 gives power to provinces to set land price reflecting local conditions. As a result, in recent years, land acquisition and resettlement procedures in Viet Nam are facing fewer obstacles.

The following laws of the Socialist Republic of Viet Nam are relevant:

- The Constitution of the Socialist Republic of Viet Nam, 15 April 1992, stipulates the right of citizens to own a house and protect this ownership;
- Land Law No. 13/2003/QH11 dated 26 November 2003, effective since 1 July 2004, is a comprehensive land administration law;
- Decree No. 17/2003/ND-CP promulgates the regulation on the exercise of democracy in communes (ward), including requirements for consultation with and participation of people in communes;
- Law of Construction, Presidential Order 26/2003/L-CTN dated 10 December 2003, which came into effect 01 Jan 2004, stipulates compensation and relocation of people affected by land

acquisition for investment projects;

- Decree No. 181/2004/ND-CP, dated 29 October 2004, clarifies the implementation of the Land Law;
- Decree No 182/2004/ND-CP, 29 October 2004 stipulates the penalties for administrative violation in land issues;
- Decree No. 188/2004/ND-CP, dated 16 November 2004, and Decree No. 123/2007/ND-CP specify methods for land pricing and issuance of land price framework for land categories;
- Circular 114/2004/TT-BTC, guides the implementation of Decree 188;
- Decree No. 198/2004/ND-CP, 03 December 2004 issued by Ministry of Finance stipulates the collection of land tax and related Circular No. 117/2004/KT-BTC;
- Decree No. 197/2004/ND-CP dated 03 December 2004, which replaces Decree No. 22/CP, stipulates compensation, assistance and resettlement when land is acquired by the State;
- Circular 116/2004/TT-BTC, guides the implementation of Decree 197;
- Decree 16/2005/ND-CP, stipulates implementation of the Construction Law;
- Decree No. 08/2005/ND-CP dated 24 January 2005 stipulates the regulations on Urban Planning Management;
- Decree No. 95/2005/ND-CP, dated 15 July 2005 stipulates the regulations on property ownership and the right to use urban residential land;
- Decree No. 131/2006/ND-CP dated 9 November 2006 stipulates the regulations on management and utilization of Official Development Assistance (ODA) (on which international commitments of the Government are prevailing and enforceable);
- Decree No. 17/2006/ND-CP dated 27 January 2006 (amending Decree No. 181/2004/ND-CP and Decree No. 197/2004/ND-CP and other Decrees) stipulates compensation, assistance and resettlement when land is acquired by the State;
- Decree No. 84/2007/ND-CP supplements stipulations on the issues of land use rights certificates (LURC), land acquisition, land use right implementation, procedure of compensation and assistance, and grievance redress.
- Circular No. 145/2007/TT-BTC issued by Ministry of Finance provides the guidelines for implementation of the Decree No. 188/2004/CP;
- Decree No. 123/2007/ND-CP; amending and supplementing Decree No. 188/2004/ND-CP gives Provincial People’s Committees the authority to set local land prices by establishing ranges for all categories of land;
- Decision No. 48/2008/QD-TTg issued on 3 April 2008 by the Prime Minister, provides common general guidelines on feasibility study preparation for projects funded by ODA by the five banks (including JBIC, now part of JICA).
- Circular No. 14/2009/TT-BTNMT dated 1 October 2009 by the Ministry of Natural Resourses

and Environment, effective since 16 November 2009, specifies the details on compensation, assistance and resettlement and procedures of land acquisition, land allocation, and land rental; and

- Decree No. 69/2009/ND-CP, effective since 1 October 2009, is an amendment to Decree No. 197/2004/ND-CP stipulating supplementary regulations on land use planning, land prices, land acquisition, compensation, support and resettlement.

Other related laws are:

- Decree No. 172/1999/ND-CP, Article 25, and its 2009 amendment, stipulates that sites, which are currently recognized for cultural and historical preservation and that are situated within the boundaries of waterway safety corridors, should be kept intact according to current legal regulations;
- Inter-Ministry Circular 02/2010/TTLT-BTNMT-BTC dated 8 January 2010 provides instructions to the development, assessment and issuance and revision of land price framework under the authorities of provincial/cities peoples' committee.

11.3.2 Analysis of the Vietnamese Legal Framework

Under the 2003 Land Law, ownership of land in Viet Nam resides with the State. The State exercises the right to decide the purpose of land use specified in land use planning and land use plans; to regulate the duration of land use; to decide on land allocation; to rent land; to acquire land, and to evaluate land prices. The State can assign and lease land to any land users, including individuals, households and organizations. The State delegates to the Provincial People's Committees (PPC) the authority to grant Land Use Right Certificate (LURC) to land users. With respect to land acquisition, resettlement and compensation, the Land Law makes the following provisions:

- The State reserves the right to "recover" (acquire) land for purposes of defense, national security, national interests, public interests, and economic development.
- Individuals, households and organizations that have or are eligible to be granted LURC will receive compensation for the loss of these assets in case of land acquisition (Article 42[1]).
- Before land is "recovered" (acquired), the user must be informed of the reasons for recovery; the schedule and plans for resettlement, if necessary; and, options for compensation. This must occur at least 3 months prior to the recovery of agricultural land and 6 months prior to the recovery of non-agricultural land (Article 39).
- Compensation for recovered agricultural and rural residential land will be in the form of new land of the same purpose of use or, if no new land is available, cash equivalent to the "land use right value" of the recovered land (Article 42[2] and [3]). In the latter case, the value is established as the value of similar land under normal market conditions, as determined on an annual basis by PPCs (Article 56).
- Farmers whose land is "recovered" but no agricultural land is available for compensation will receive cash compensation and, support from the State to find new employment or to retrain to

work in new occupations (Article 42[4]).

- Where the land use right value of recovered residential land is greater than that of the land given as compensation, affected people will receive cash equal to the difference in the values (Article 42[3]).
- Resettlement zones will be developed for people whose residential land is recovered and are forced to move their places of residence. Resettlement zones will be developed for multiple projects at the same area and will provide living conditions that are equal to or better than the conditions in the former places of residence. In areas where there is no established resettlement zone, people will receive cash for recovered residential land and have priority to purchase or lease State-owned dwellings (Article 42[3]).
- Recovery of land will occur without compensation in the following cases, among others: (i) land is recovered from organizations that use State funds to pay land use levies for assigned land or land rentals for leased land, or are assigned land without having to pay land use levies; (ii) recovered land has been illegally encroached or occupied, or the occupants are not eligible to be granted land use right certificates; (iii) recovered land is rented from the State; and, (iv) recovered land is road or canal, or used for cemeteries or graveyards (Article 43[1]).
- Structures and other fixed assets on recovered land will not be compensated in cases where they have been constructed without permission; in contravention of permitted uses in land use plans; or, when structures are located on illegally encroached land (Article 43[2]).
- In the event of temporary recovery of land, for example during construction, upon the expiry of temporary land acquisition the State will return the land and pay compensation for any damages (Article 45).

Land Law 2003 defines the principles for the State’s evaluation of land prices:

- These should reflect the market price of land use right transfer in normal market conditions. In the event that there is a significant difference between the identified land prices and the local market ones, the price offered should be adjusted accordingly;
- Plots bordering each other that have: i) similar natural, socio-economic, and infrastructure conditions, and ii) similar existing and/or planned type of land use, will have similar land prices;
- Land located in areas on the borders between provinces, cities under direct Central Government’s management, that have i) similar natural, socio-economic, and infrastructure conditions, and ii) similar existing and/or planned type of land use, will have similar land prices.

Land Law 2003 also provides that land prices regulated by the PPC or PC of Cities under the direct Central Government, will be publicly announced on 1st January annually. If at the time of land recovery, the land price specified by the PPC differs from the actual market price under normal conditions, the PPC shall re-determine the land price to ensure that it is fair and appropriate.

Decree No. 197/2004/ND-CP regulates the eligibility and procedures for compensation, assistance and resettlement in the event of State recovery of land. The principles for compensation are: (i) recovery of land from eligible persons shall be compensated; (ii) in the event the affected person is not eligible for compensation, consideration will be given to provide assistance; (iii) compensation for affected land will be in the form of new land allocation with the same purpose of use or, if no such land is available, cash compensation equal to the value of land use rights at the time of recovery; and, (iv) outstanding financial liabilities associated with the land to be recovered will be deducted from the amount of compensation or assistance money. The Decree and Circular No. 116/2004 TT-BTC set out in detail the types of compensation for different types of users and losses; assistance policies; provisions for individual and group resettlement; and, the roles and responsibilities for implementation of resettlement.

Decree No. 17/2006/ND-CP amends Decree 197 to strengthen several aspects of the provisions for compensation, support and resettlement, including: (i) a requirement to update official PPC prices as necessary, to reflect market values for affected assets; (ii) life stabilization assistance for affected households with low income, for at least three years to a maximum of ten years; and, (iii) assistance for occupational change and job creation for affected households losing significant portions of their productive assets, as well as for affected households that relocate to resettlement sites.

Decree No. 188/2004/ND-CP regulates the methodology for determining land prices and price frameworks for State recovery of land, as well as for taxation on land use and the transfer of land use rights and rental of government lands. It establishes the minimum and maximum prices for different types and categories of land. The principle underlying the determination of land prices is the actual market price under normal conditions between a willing seller and buyer without regards to factors such as speculation, changes in planning, forceful transfer or blood relationship. Circular No. 114/2004/TT-BTC elaborates in detail the methods (direct comparison and income methods) for determining land prices.

Decree 123/2007/ND-CP amends Decree 188/2007/ND-CP giving the Provincial People's Committees the authority to set local land prices by establishing ranges for all categories of land.

Decree 69/2009-ND-CP regulates compensation payments. Where compensation is made in the form of a new piece of land or house for resettlement and there is a difference in value, then the resettled person is entitled to the difference if the support money is less than the value of the new land or house; and on the other hand, the resettled person pays the difference if compensation is greater than the value of the new land or house (except in special circumstances). State support includes: (i) removal support, resettlement support when residential land is acquired; (ii) support for life and production re-stabilization, for retraining and job creation where agricultural land is acquired; (iii) support for acquisition of "agricultural use" land in residential areas e.g., gardens, ponds; and (iv) other support. The PPC shall specify in detail the compensation amount, the support land area and the average price for calculations appropriate to the local reality.

Decree No. 131/2006/ND-CP provides that in case of "*discrepancy between the Vietnamese Law and any provision in an international treaty on Official Development Assistance to which the Socialist Republic of Viet Nam is a signatory, the provision in the international treaty on ODA shall take precedence*" (Article 2, Item 5).

11.3.3 Legal and Institutional Framework of Dong Nai Province

There are specific regulations promulgated by DNPPC on resettlement procedure and determination of price applicable to Dong Nai Province. These are shown as follows.

- Decision No.: 20/2010/QD-UBND, dated 05 April 2010 promulgates policies on support, criteria and procedures for consideration of resettlement for the State acquired land in Dong Nai Province.
- Decision No.: 21/2010/QD-UBND, dated 05 April 2010 promulgates procedures for compensation, support, resettlement, land acquisition, land allocation, and land lease in Dong Nai province.

The most important legal document related to the RAP preparation in Dong Nai Province is the Decision No. 21/2010. This is a very elaborate document on the procedures for RAP preparation, compensation preparation and appraisal, and implementation. The important directions are:

- DNPPC will form a Compensation, Support and Resettlement Committee (CSRC) for each project to implement resettlement /compensation activities.
- General composition of the CSRC is given in the Decision 21. CSRC will be headed by chairman or vice chairman of the district PC (for example, in case of this Project, Bien Hoa City PC).
- DNPPC can assign Center for Land Development (CLD) to prepare the CSRP and assist in implementation. CLD must work under CSRC.
- Based on application by DONRE, PPC will issue a land acquisition notice to the residents living/ using the land to be acquired.
- DONRE should arrange public notification and consultation.
- DNPPC will establish the CSRC for the project, including representatives of Project Affected people (PAPs).
- A survey should be conducted in the proposed acquire area. The details of the inventory content and survey procedure are elaborated in the Decision 21.

- The inventory has to be confirmed by respective Ward PC.
- The District (or in case of this Project, Bien Hoa City) Office of Land Use Right Registration (under Division of Natural Resources) and Division of Urban Management shall be responsible for appraisal of the land use right.
- A draft Compensation, Support, and Resettlement Plan (CSRP) will be prepared based on an inventory of affected properties that complies with Decree No. 69/2009.
- The draft CSRP will be posted and the public consulted.
- The draft CSRP will be finalized incorporating public opinion, if any.
- DONRE will then arrange appraisal of the CSRP by forming an evaluation committee.
- The evaluated CSRP will be submitted to Bien Hoa CPC for final approval.
- The approved CSRP must be posted publicly.
- After approval, each PAP will receive respective support and compensation notification.
- The payment of compensation shall be dispursed by the organization in charge of compensation planning (like CLD), in coordination with the project owner (like PMU) and the state treasury or a bank.
- The fees to be paid for resettlement planning are as follows: 1.6% of the compensation budget to the organization preparing the CSRP (for example, to CLD) and 0.4% to the evaluation committee.
- Settlement of complaints shall be implemented based on 2003 Land Law, Decree 69/2009 and Decree 136/2006.

11.3.4 JICA Policy and Principles

Japan’s ODA Charter states that in formulating and implementing assistance policies, Japan will take steps to assure fairness. This will be achieved by giving consideration to the conditions of the socially vulnerable and to the gap between rich and poor, as well as the gaps among various regions in developing countries. Furthermore, when implementing ODA, great attention will be paid to factors such as environmental and social impacts.

JICA, which is responsible for handling Japan’s ODA, plays a key role in contributing to sustainable development in developing countries. The inclusion of environmental and social costs in development costs and the social and institutional framework that makes such inclusion possible are crucial for sustainable development. JICA is keen to ensure that there are no negative environmental and social impacts from the project activities. It is important to ensure stakeholder participation, full information disclosure, accountability, and efficiency, in addition to the respect for human rights, and transparent decision-making.

While project proponents are ultimately responsible for the environmental and social considerations of the projects, JICA supports them through activities similar to this Preparatory Study to avoid or minimize impacts on the environment and local communities.

JICA's "Guidelines for Environmental and Social Considerations" was updated in April 2010, and the new version became effective July 2010. Since this Project has been initiated before that date, "JBIC Guidelines for Confirmation of Environmental and Social Considerations, 2002" would apply for the evaluation of this Project. The 2002 guidelines mention that:

- Involuntary resettlement and loss of means of livelihood are to be avoided where feasible, exploring all viable alternatives. When, after such examination, it is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected;
- People to be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by the project proponents in a timely manner. The project proponents must make efforts to enable the people affected by the project to improve their standard of living, income opportunities and production levels, or at least to restore them to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting the means for an alternative sustainable livelihood, and providing the expenses necessary for relocation and re-establishment of a community at relocation sites; and
- Appropriate participation by the people affected must be ensured and their communities must be involved in planning, implementation and monitoring of involuntary resettlement plans and measures against the loss of their means of livelihood.

Furthermore, in the scope of this Preparatory Study II, JICA mentions that it is desirable that the resettlement action plan (RAP) include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A. (Ref: JICA's TOR for this Preparatory Study II, in Japanese)

11.3.5 World Bank Policies

The World Bank Policies on involuntary resettlement can be found in their Operational Policy OP 4.12, prepared in December, 2001 and later updated in March, 2007. Some of the major aspects are explained below.

- In addition to compensation for land and structure, it calls for providing assistance (such as moving allowances) during relocation;
- Offer support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living;
- Provide assistance for land preparation, credit facilities, training, or job opportunities;
- Particular attention is paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, the landless, the elderly, women and children, indigenous peoples, ethnic minorities, or other displaced persons who may not be protected through national land

compensation legislation;

- Host community should be consulted and provided with improved infrastructure;
- Even the non-title holders should get compensation;
- Loss of asset should be compensated based on the re-acquisition cost;
- The full costs of resettlement activities are included in the total costs of the project. The costs of resettlement, like the costs of other project activities, are treated as a charge against the economic benefits of the project.

As a JICA suggested benchmark, World Bank Safeguard Policy, OP 4.12, Annex A is explained here. That particular annex describes the elements of a resettlement plan. It is recommended that the RAP or CSRP of this Project should follow this documentation structure. The resettlement plan should cover the following elements:

1. Description of the project
2. Potential impacts
3. Objectives
4. Socioeconomic studies
5. Legal framework
6. Institutional framework
7. Eligibility
8. Valuation of and compensation for losses
9. Resettlement measures
10. Site selection, site preparation, and relocation
11. Housing, infrastructure, and social services
12. Environmental protection and management
13. Community participation
14. Integration with host populations
15. Grievance procedures
16. Organizational responsibilities
17. Implementation schedule
18. Costs and budget
19. Monitoring and evaluation

11.3.6 Key Differences between Policies

Recent Laws, Decrees and Regulations bring the Vietnamese resettlement policies and practices closer to those of the World Bank. The outstanding differences are shown in Table 11.3.1.

Table 11.3.1 Key Differences between Vietnamese Laws and the World Bank Policies

Key Issues	Viet Nam National Laws	World Bank Policies
Non-titled users	Generally no entitlement. Decree 69/2009, Article 14 (replacing Decree 197/2004, Article 6), the Peoples' Committees of the provinces or centrally-run cities shall consider providing any support on case-by-case basis.	The absence of formal legal title to land by some affected persons should not prevent compensation.
Compensation of land at replacement cost	Decree 123/2007 (amending Decree 188/2004), sets price limits of land and authorizes Provincial Peoples' Committees to set local land prices. The price limit would not be allowed to vary by more than 20 per cent against a bench-mark price. Article 11 of Decree 69/2009ND-CP stipulates that, if at the time of land recovery, the land price specified by the PPC is different to the actual market price under normal conditions; the PPC shall determine the land price again so that it is specific and suitable.	Compensate or assist all affected persons for all their losses at 'replacement cost'.
Structures constructed without authorization	Land Law 2003 mentions that, structures and other fixed assets on recovered land will not be compensated in cases where they have been constructed without permission; in contravention of permitted uses in land use plans; or, when structures are located on illegally encroached land (Article 43[2]).	Compensate or assist all affected persons, including those without authorization, for all their losses at replacement rates.
Non-registered business	Decree 187/2004, Articles 26-28: Only registered businesses are eligible for assistance.	For non-land assets, all eligible affected people, whether titled, eligible, or non-titled, need to be compensated at replacement cost, through cash or replacement assets. Also included: the tenants of affected buildings, and employees of affected businesses.
Provision of rehabilitation assistance	Decree 69/2009, Article 20 & 22: PAPs losing 30% or more of productive land will be entitled to "living stabilization and training/job creation assistance". Decree 17/2006 strengthens this provision and provides for long-term assistance to poor households.	Rehabilitation assistance is required for those who lose any of their productive income generating assets and/or are physically displaced. Focus to avoid further impoverishment and create new opportunities to improve the status of the poor and vulnerable people.
Attention to the needs of vulnerable groups	Provision of support for ethnic minorities and vulnerable groups including ultra poor, war veteran, sick soldiers, etc. However, there is no special mention for female headed, landless and elderly headed households.	Calls for particular attention to be paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, the landless, the elderly, women and children, indigenous peoples, ethnic minorities, or other displaced persons who may not be protected through national land compensation legislation.
Host community	No detail description.	Host community should be consulted and provided with improved infrastructure

11.3.7 Recommended Project Policy

With the promulgation of recent laws and regulations, current Vietnamese land acquisition and involuntary resettlement policy is well prepared. Thus, RAP under preparation for this Project is expected to fulfill most of the requirements of the international development partners. However, there are some minor differences in terms of compensation calculation, entitlement of illegal occupants, etc. It is recommended that more flexible approach be taken in the RAP preparation for this Project reflecting the best practices of the World Bank Policy.

The recommended principles for resettlement policy in the Project are given below. JICA Study Team discussed the recommended principles with the PMU and requested that these should be covered in the RAP.

i. Acquisition of land and other assets, and resettlement of people will be minimized as much as possible.
ii. All Project Affected Persons (PAP) residing, working, doing business or cultivating land within the recovered area for the Project as of the cut-off-date, are entitled to be provided with rehabilitation measures sufficient to assist them to at least maintain or improve their pre-Project living standards, income earning capacity and production levels. Lack of legal rights to the assets lost should not bar the PAP from entitlement to such rehabilitation measures.
iii. The rehabilitation measures to be provided are:
    a. compensation at replacement cost, without deduction for depreciation or salvaged materials from houses and other structures;
    b. priority given for agricultural land-for-land of equal productive capacity acceptable to the PAPs;
    c. replacement of residential land of equal size and acceptable to the PAPs;
    d. transportation and subsistence allowances; and
    e. business/income rehabilitation allowances (even for non registered businesses).
iv. Replacement of residential and agricultural land should be as near as possible to the land that is lost, and acceptable to the PAP. In the event that there is no land available for ‘land for land’ compensation, or if it is the choice of PAPs, then compensation in cash or provision of apartment may be applied (for PAPs losing residential land and relocating).
v. Particular attention should be paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, the landless, the elderly, women and children, indigenous peoples, ethnic minorities, or other displaced persons who may not be protected through national land compensation legislation.
vi. The resettlement transition period will be minimized and the PAPs shall be supported for transportation allowance, and house renting allowances as specified by the PPC.
vii. Plans for acquisition of land and other assets and provision of rehabilitation measures should be carried out in consultation with the PAPs to ensure minimal disturbance. Entitlements will be provided to PAPs no later than one month prior to the expected start-up of civil works at the respective project sites.
viii. The previous level of community services and resources should be maintained or improved.
ix. Infrastructure should be improved for the host community.

x. Adequate budgetary support should be fully committed and made available to cover the costs of land acquisition, resettlement and rehabilitation within the agreed implementation period. Physical resources for resettlement and rehabilitation should be made available as and when required.

xi. Civil works contractors will not be issued a notice of possession or a notice to proceed unless the PMU has

  a. Satisfactorily completed compensation payments in accordance with the RAP, and

  b. Ensured rehabilitation assistance is in place.

xii. Institutional arrangements should ensure effective and timely planning and implementation of the RAP.

xiii. Appropriate reporting, monitoring and evaluation mechanisms should be identified and set in place as part of the resettlement management system. The process for the evaluation of land acquisition and final outcome should be independent of the executing agency.

11.4 Activities and Findings by JICA Study Team

The JICA Study Team assessed the field conditions related to land acquisition and involuntary resettlement. These include compilation of socioeconomic data of the Project affected area, analysis of resettlement issues in similar projects, field visits to the proposed Project sites and proposed relocation sites, information exchange with PMU, Ward PC and Center of Land Development (CLD) and other relevant agencies, and conducting a public consultation with the affected persons through Focus Group Discussions (FGDs).

11.4.1 Socioeconomic Situation of the Project Affected Area

The Project components that would require land acquisition and resettlement include the construction of STP2, PS1, and canal improvement. Information of the socioeconomic situation of the proposed sites collected from the ward PC is summarized below.

According to a report on poverty reduction between 2006 and 2010, there are only 732 households below the extreme poverty line (0.3% of the total). Bien Hoa is a rapidly developing area with a high level of industrial activities. The 5 year average GRP growth of Bien Hoa is 14.5%. In 2009, because of the economic slowdown, the growth rate dropped to 10.32%, but it is expected that it would bounce back to 14% in 2010.

The socioeconomic conditions of the 2 wards where the STP2 and PS1 will be located are given below. The available respective data for the living quarters where the construction will take place are also shown in the tables.

Table 11.4.1 Socio-economic Situation around Proposed STP2 Site (Tam Hiep Ward)

No.	Items	Unit	Tam Hiep Ward	Living Quarter No. 2
1	Total population	persons	33,192	4,714
2	Households	numbers	9,019	1,308
3	Total female population	persons	17,546	2,525
4	Total population, age 18-60	persons	22,582	3,263
5	Total population, age > 61	persons	1,922	216
6	Ratio of poor household*	%	2.3	2.5
7	Household having television	%	89	91
8	Household having telephone	%	56.6	51
9	Household connected to piped water	%	69	N/A
10	Average monthly income per capital	VND	850,000	N/A
11	Total ethnic people	persons	530	140

Note: N/A: Data not available/ Data not obtained

* As per Resolution No. 176/2010/NQ-HDND issued by Dong Nai People's Council dated 2 July 2010, a household is ranked as poor when the household monthly per capita income is less than VND 850,000.

Source: Tam Hiep Ward People's Committee, Nov 2010

Table 11.4.2 Socio-economic Situation around Proposed PS Site (Thong Nhat Ward)

No.	Items	Unit	Thong Nhat Ward	Living Quarter No. 6
1	Total population	persons	22,786	2,491
2	Households	numbers	5,721	N/A
3	Total female population	persons	12,230	N/A
4	Total population, age 18-60	persons	16,320	N/A
5	Total poor household *	numbers	156 (2.7%)	16
6	Household having television	number	5,389 (94%)	572
7	Household having telephone	number	3,475 (61%)	358
8	Household connected to piped water	%	95	N/A
9	Average monthly income per capital	VND	900,000	N/A
10	Total ethnic people	persons	N/A	N/A

Note: N/A: Data not available/ Data not obtained

* As per Resolution No. 176/2010/NQ-HDND issued by Dong Nai People's Council dated 2 July 2010, a household is ranked as poor when the household monthly per capita income is less than VND 850,000.

Source: Thong Nhat Ward People's Committee, November 2010

Canal improvements will be carried out in 8 wards. Small sections of many living quarters will be affected. Therefore, it would be useful to have the socioeconomic data for each ward. The data for Thong Nhat, are already shown in Table 11.4.2. The basic data for the remaining 7 wards are presented below.

Table 11.4.3 Socio-economic Situation around Proposed Canal Improvement

No.	Items	Unit	Trang Dai	Ho Nai	Tan Hoa	Binh Da	Tan Hiep	Tan Bien	Tam Hoa
1	Total population	persons	58,294	32,034	39,526	17,382	32,399	37,118	18,201
2	Households	numbers	14,492	8,008	7,186	3,373	5,873	6,259	3,365
3	Total female population	persons	50.8	48.6	47.7	53.5	52.3	51.2	51.3
4	Total population, age 18-60	persons	31,938	23,113	16,240	14,052	16,850	23,250	N/A
5	Ratio of poor household (*)	%	0.9	0.6	0.2	0.2	0.4	1.56	0.95
6	Household having television	%	98	100	100	100	100	100	100
7	Household having telephone	%	83	93	67	85	100	89	85
8	Household connected to piped water	%	10	90	45	80	60	30	90
9	Average monthly income per capital	m VND	1.8	1.75	2.04	1.5	N/A	1.2	1.3
10	Total ethnic people	persons	108	0	35	1,313	41	9	261

Note: N/A: Data not available/ Data not obtained
* As per Resolution No. 176/2010/NQ-HDND issued by Dong Nai People's Council dated 2 July 2010, a household is ranked as poor when the household monthly per capita income is less than VND 850,000.
Source: Thong Nhat Ward People's Committee, November 2010

11.4.2 Lesson Learned from Similar Projects in Viet Nam

Before the 2003 Land Law came into effect in 2004, there was no clear legal framework for resettlement planning or implementation. As a result, there are legacies of protracted resettlement issues associated with many development activities. For example, the resettlement activities for one project in Dong Nai province that was started in 2003, has not been completed yet. However, with the current legal framework, such situation is not expected to occur for this Project.

The Decree 197/2004 and its amendment Decree 69/2009 not only elaborate the compensation entitlement but also provide the outline for resettlement planning. Since it only came into effect October 2009, there are only a few examples of RAP prepared based on this Decree. The Decisions No. 20 and 21/2010 promulgated by DNPPC in April 2010 further streamline the preparation of RAP and calculation of compensation. An acceptable RAP can be prepared following these Decrees.

For the implementation process, the most often reported difficulty is the non availability of the relocation site. Bien Hoa CPC is preparing multiple relocation sites. It is expected that these sites would be ready at the time of resettlement execution of this Project.

Another reported issue is the compensation amount. It is recommended that more flexible approach be taken to avoid similar problems thereby accelerating project implementation.

11.4.3 Site Investigations

Field visits to proposed Project sites:

The proposed STP2 site is located by the side of the Cai River. There are many fish ponds and some houses are situated in the proposed area. There will be full relocation for around 75 households. On the other hand, the canals to be developed run through very congested and highly developed areas. So it is expected that a lot of households will be affected.

	
Houses to be relocated at the proposed STP2 site	Fish ponds at the proposed STP2 site
	
Houses to be relocated on the bank of the canal	Houses to be relocated on the bank of the canal

Figure 11.4.1 Photos of the Project Sites

Field visits to proposed relocation areas

As per regulations of DNPPC, the eligible affected households can select compensation options that are suitable to their requirements, either as land, apartment or cash. Currently Bien Hoa CPC is preparing relocation areas, both land and apartment.

Field visits to 3 relocation areas were conducted by the JICA Study Team. These are (i) Buu Long relocation area at Buu Long Ward, (ii) Tan Bien relocation area at Tan Bien Ward, and (iii) a high rise building at Nguyen Van Troi Str., Quang Vinh Ward. Objectives of the field visits to these resettlement areas are to check their status of development as well as living conditions. Locations of these relocation areas are presented in Figure 11.4.2. Pictures of these areas are shown in Figures 11.4.3, 11.4.4 and 11.4.5.

The total land size of Buu Long and Tan Bien Phase I resettlement areas are 9 ha and 9.2 ha, respectively. The Tan Bien Phase I site has 504 plots. The necessary infrastructures such as power supply, street lightning, access road, internal road, water supply, drainage, etc. are under construction. Tan Bien relocation area is located just 2 km away from the proposed STP2 site; and would be the better alternative between 2 relocation areas. The ward office of Tan Bien also mentioned that there were plans to expand the nearby school and the construction of a new secondary school. According to the RAP Framework document (PMU, 2011) all infrastructure in these 2 locations will be ready by 2011.

The building at Nguyen Van Troi Street is an 11 storied high rise, which accommodates 115 apartments. It will also house car parks on 1st floor and shops on the 2nd floor. There are 2 types of apartment, namely 80 m^2 and 100 m^2. It is expected that before the end of 2011, people can move into this building.

Figure 11.4.2 Map Showing Locations of Relocation Areas for Resettled Persons in the Bien Hoa City

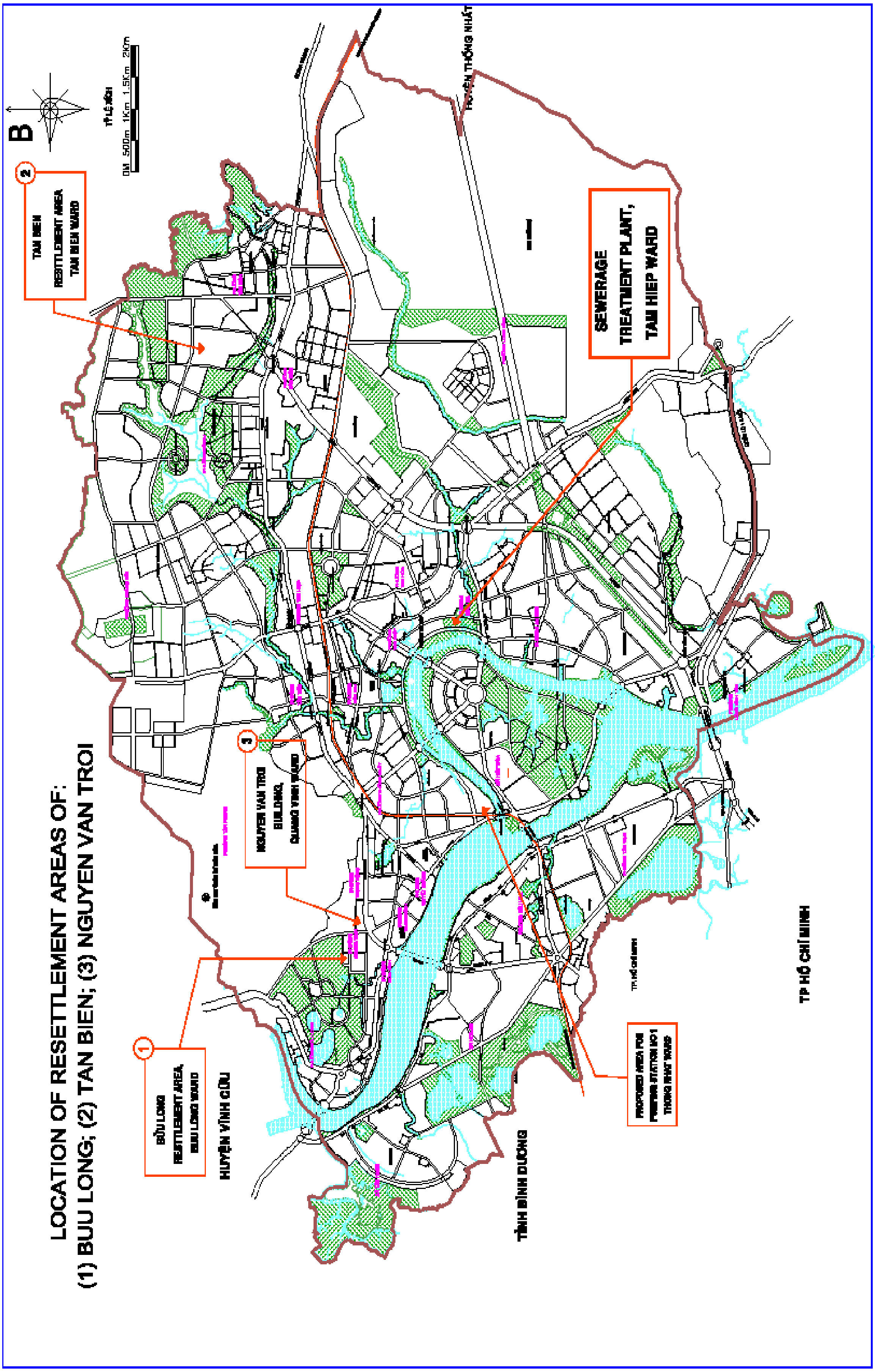


Figure 11.4.3 Pictures of Buu Long Resettlement Area, Buu Long Ward

Figure 11.4.4 Pictures of Tan Bien Resettlement Area, Tan Bien Ward

Planned outlook view	Current state of progress (Dec 2010)

Figure 11.4.5 Pictures of Resettlement Building at Nguyen Van Troi Str., Quang Vinh Ward

11.4.4 Stakeholder Consultations

Consultation with PMU, Ward PC, CLD and other relevant agencies

JICA Study Team carried out a series of consultation meetings with the PMU, Ward PCs, Center for Land Development (CLD), and PMUs of other relevant projects. This was conducted to assess the organizations' internal capability, interaction with the public and effectiveness of the whole process.

Public Consultation Meeting at Tam Hiep Ward

A public consultation meeting was conducted by the JICA Study Team at Tam Hiep Ward Office on 2 December 2010. Participants at the meeting include; 15 representatives of the affected households from the proposed STP2 site, 2 officials of Tam Hiep Ward PC including its chairperson; and 2 officials of PMU. Objective of this meeting was to identify the process as well as effectiveness of the resettlement related activities carried out by concerned organizations. Items on the agenda include objectives of the Project, plan on land acquisition, inventory survey, compensation options, compensation calculation and implementation. It was conducted following the Focus Group Discussion (FGD) methodology. Participants' opinions and observations were first collected anonymously and then invited for a discussion. The pictures are given in the Figure 11.6.6. JICA Study Team requested the PMU representatives present in the meeting to take note of the public opinions, views and suggestions during the preparation of RAP document and implementation of RAP.

The main findings from this consultation are:

- Information relating the Project was provided to the affected households well in advance. However, details of the Project components are not clear to them.
- Information relating to the resettlement was provided through a number of public consultations carried out by PMU, Bien Hoa CPC and Center for Land Development, held between August and November, 2010.
- However, they do not have much understanding on the resettlement policy and compensation process.
- It was observed that the PAPs fully understand the importance of the Project and are motivated to support the Project.
- They requested that land price be calculated to reflect the current market price.
- They requested for compensation of loss income from loss of business activities.
- They do not know about the locations of relocation areas.
- They requested that the relocation area be as close as possible to their present houses.
- Affected households have no clear knowledge on grievance redress mechanisms.
- They are generally satisfied with the inventory survey as recorded by the surveyors.

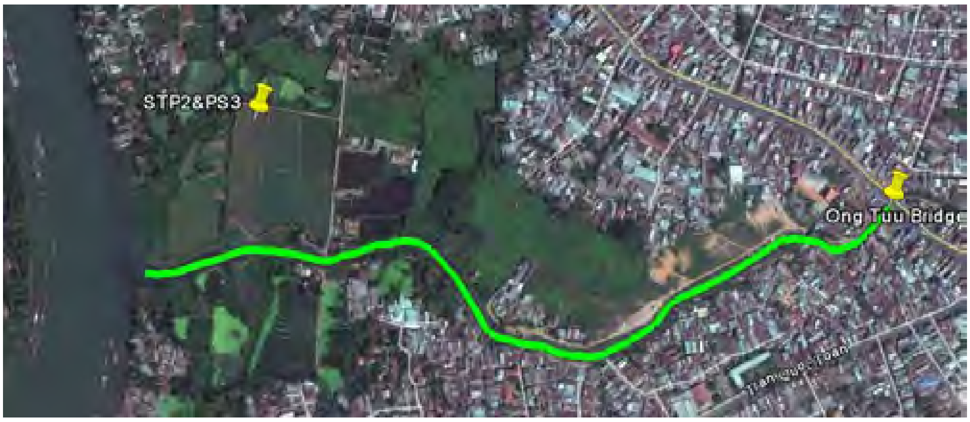
Meeting in session

The problem chart

Figure 11.4.6 Pictures of the Focus Group Discussion

11.4.5 Confirmation of Land Acquisition and Resettlement Status for Linh Stream Improvement

As requested by the PMU (Minutes of Meetings between JICA Study Team and PMU, 26th January, 2011), the improvement of Linh Stream, from National Highway No. 15 to Cai River (about 1.18 km length), as shown in Figure 11.4.7, is now part of the Dong Nai Water Environment Improvement Project, Sewerage and Drainage Sector (this Project). At present, Linh Stream is a heavily polluted stream receiving wastewater from households, public and business entities, especially from a large number of pig farms. Measures for Linh Stream pollution control are explained in Chapter 4 of this Report.



Source: JICA Study Team, based on Google Map.

Figure 11.4.7 Linh Stream (green line) from Ong Tuu Bridge to Cai River

For the stream improvement, land is required permanently along the both banks. The status of land acquisition and resettlement in relation to Linh Stream improvement has been investigated by the JICA Study Team.

During March/April 2011, JICA Study Team: (i) interviewed Dong Nai PMU; (ii) reviewed as-built drawing of the earlier project; (iii) conducted a site visit to Linh stream; and (iv) interviewed households living in the area. Findings from the investigation are as below:

- Between 2003 and 2009, Bien Hoa CPC implemented a project, namely "Wastewater Drainage Project for Linh Stream" which aimed to improve wastewater drainage and enhance environmental conditions of the Linh stream. The project included: (i) widening all parts of the Linh Stream by up to 30 meters; and (ii) building a concrete bank lining for 1,500 meters of the stream (upstream of the Ong Tuu Bridge). The bank protection for the downstream portion was not included in the project.
- That project was completed in 2009 (Ref: As-Built Drawing dated 2009 by Thuan An Anh Co. Ltd.)
- The project required land acquisition of 550 households living near the banks of the Linh Stream.
- Land acquisition, resettlement and compensation were undertaken by Bien Hoa Compensation Committee and completed by 2003.
- PAPs were compensated properly for house and land. They also received compensations for asset, structure and affected land.
- Almost all PAPs were satisfied with the compensation level and acquired lands were handed over to the Bien Hoa Project Management Unit.
- Boundary markers for the right-of-way were established along the banks of Linh Stream. (ref: Fig. 4.8.5)
- Presently, almost all households' structures are relocated outside of the acquisition land.

However, some households had encroached into the already recovered land and constructed houses, kitchens, fence, yards, etc. These households are required to remove all these structures and return the encroached land to the State without receiving any compensation.

- 560 m^2 land was acquired out of a total of 700 m^2 from the household headed by Mrs. Nguyen Thi Quy in Binh Da Ward and Mrs. Quy received the full compensation amount in 2003. However, until now, only 200 m^2 was handed over to Bien Hoa City.

Based on the above findings, it is recommended that land acquisition of Mrs. Quy not to be included in the ongoing RAP prepared by PMU of Dong Nai Water Environment Improvement Project (this Project), since it belongs to a different project (Wastewater Drainage Project for Linh Stream) and the household already took compensation in cash and handed over part of the affected land. Therefore, JICA Study Team would like to recommend that Bien Hoa CPC solve the problem before the commencement of this Project. JICA Study Team also explained to the PMU that if any dispute still remains before the JICA appraisal mission, this component might be excluded from this Project.

11.5 Recommendations on Resettlement Action Plan Preparation

11.5.1 Overview

PMU has the responsibility to prepare the RAP document. The JICA Study Team provided some guidance in December, 2010 which would help PMU comply with both Vietnamese regulations and JICA recommendations in the preparation of the RAP. The JICA Study Team recommendations are given in this section.

11.5.2 Inventory and Baseline Survey

The RAP document should include results of the inventory survey. The contents of this survey should contain a summary of identified PAPs, their assets including all measurements, their opinion on compensation options, their socioeconomic condition, their entitlement, any special considerations (like ethnic minority), etc.

In addition, it is also important to carry out a social baseline survey in the project affected area and host area. The contents should include demographic description, income level, expense regime, employment type, education level, household amenities, access to utilities, etc. Few years after the completion of the Project, a follow up survey should be carried out. By comparing the baseline and follow up surveys, the impact of the Project and the resettlement could be assessed.

11.5.3 Principles of Compensation Policy

The RAP document should include principles of compensation policy.

Compensations are expected to be paid to current users of land “recovered” (acquired) by the State following the Government laws, decrees, and regulations promulgated and by the decisions of

DNPPC. The relevant decrees, circular and decisions are: (i) Decree No. 197/2004/ND-CP; (ii) Decree No. 84/2007/ND-CP (iii) Decree No. 69/2009/ND-CP; (iv) Circular No. 14/2009TT-BTNMT; and (v) DNPPC Decisions no 20/2010/QD-UBND and 21/2010/QD-UBND dated 5 April 2010.

Compensations and supports for specific assets according to Vietnamese standard are likely to be as below:

For land:

i. Compensation will be paid to only current legal or eligible users of land. Support for non legal users of land will be considered case by case.
ii. State land acquisition will be compensated by new land with the same use purpose. If no land is available for compensation, compensation equal to the value of the land use right, calculated based on land prices at the time of land recovery decision, will be paid.

For establishment/house:

i. Owners of the building/structures located on the land recovered shall receive full compensation, if the use is legal.
ii. If owners of the building/structures located on the land recovered are not eligible for full compensation, they shall receive compensation or supports for the loss of property on a case-by-case basis.
iii. Houses and other structures built after the land use planning is publicized shall not be compensated.
iv. Houses and other structures built without permission of competent State bodies shall not be compensated.
v. Houses and other structures, constructed after the land acquisition notices decisions are publicized shall not be compensated.
vi. For furniture, machinery and equipment which can be disassembled and removed, compensation shall be paid only for disassembly, transport and reassembly, and damage caused in the process.

It is recommended that compensation should be paid on ‘replacement cost’ basis. Lack of legal land title document should not be a barrier to get full replacement cost. Also, it is recommended that business income loss should be considered and compensated properly.

11.5.4 Draft Entitlement Matrix

An entitlement matrix is an integral part of the RAP document.

JICA Study Team prepared a tentative entitlement matrix following Vietnamese regulations as an example. The matrix is given below.

Table11.5.1 Draft Entitlement Matrix

Types of support and compensation	Items to be compensated and supported	Compensation and Support level
1. Land acquisition	1.1 Households and individuals have to be removed as a result of residential-land acquisitions and have no other places of residence within communes, wards or townships	01 residential land quota for resettlement
	1.2 Households and individuals have their residential land recovered while the remaining land area is less than 15 m^2 (in urban area), 40 m^2 (in rural area) or one side of the land is less than 3 m and is unsuitable for residence under the regulations of DNPPC or the remaining land is not suitable for house construction and have no other places of residence within communes, wards or townships	01 residential land quota for resettlement
	1.3 Households and individuals have residential land within safety corridors of public works that have to be removed and have no other places of residence within communes, wards or townships where exists recovered land.	01 residential land quota for resettlement
	1.4 Non legal users of residential land.	DNPPC considers arranging residential place at resettlement project or residential area as specified by regulations of DNPPC. Household and individuals shall be in charge of land use cost, construction cost of the apartment (if apartment is assigned) and investment cost for the infrastructure construction.
	1.5 In case more than one family unit (different couples) live together in a household while all the conditions for separation into different households are satisfied, or different households have the common right to use one (01) land lot to be recovered	01 residential land quota for resettlement and if each sub-couple is fully satisfied with Item 5 a, b, Article 16, Decision 20 is entitled to additional residential land quota for resettlement.
	1.6 In case a number of households having common land use right of 01 land lot to be recovered and have no other places of residence within communes, wards or townships	Each household is entitled to 01 residential land quota

Types of support and compensation	Items to be compensated and supported	Compensation and Support level
	1.7 Agricultural land eligible for compensation according to Art. 8 of Decree 197/2004	a. New land with the same land use purpose as close as possible to the old location. b. If the compensated land is smaller or lower quality than acquired land, the affected people shall be compensated in cash equivalent to the difference in value. c. In case there is no land for compensation, people shall be compensated at the equivalent value in cash, if this is acceptable to them,.
2. House and structures on land	2.1 For houses and other structures permitted under the construction law to be built on land eligible for compensation	Compensation equal to the value of newly built houses and structures with equivalent technical standards promulgated by the Ministry of Construction shall be paid. The value of a newly built house or structure shall be calculated by multiplying the house's or work's built area by the unit price of a newly built house and work promulgated by DNPPC
	2.2 For houses and structures other than those specified in section 2.1 as above mentioned, compensation shall be paid as follows:	a. The level of compensation for a to be-dismantled house or structure equals the total current value of the house or structure plus 80% of this value in cash. The current value of a to be-dismantled house or work is determined as the value of a newly built house or structure with equivalent technical regulations promulgated by a line ministry multiplied by the percentage of the residual quality of the house or work. b. For a partially dismantled house or structure with the remaining part unusable, compensation shall be paid for the whole house or structure. If the remaining part still exists and is usable, compensation shall be paid for the value of the dismantled part of the house or structure and expenses for repairing and refurbishing the remaining part up to technical standards of the house or structure before it is dismantled.
	2.3 Assets attached to non legal land	No compensation
3. Tree and animals	Loss of standing crops, trees and aquaculture	Entitled to compensation for affected crops and aquaculture products in cash at a price as prescribed by DNPPC.

Types of support and compensation	Items to be compensated and supported	Compensation and Support level
4. Removal support	4.1. In case land is recovered by the State, financial support for removing households items is permitted.	a. Within Bien Hoa City: VND 4,000,000 per household. b. Within Dong Nai Province, but outside of Bien Hoa City: VND 6,000,000 per household. c. Outside of the Dong Nai Province: VND 8,000,000 per household. In case of rental housing (house rental contract is certified by a competent authority), the person shall be compensated with relocation expenses at 50% as mentioned in section a, b and c.
	4.2. Organizations having their land: (i) allocated or leased, but the amount is paid by Government; or (ii) lawfully using the lands for free.	Financial support for dismantle, relocation and installation.
	4.3 Households with full entitlement to resettlement, but the relocation area is not ready and have no other places of residence.	Be provided with makeshift lodgings or house rent support money, pending moving to resettlement area, of VND 1,500,000 per household per month. Number of months to be supported as prescribed by DNPPC. If a household has more than 06 people, additional support shall be provided.
	4.4 Households, who have 30% of their house demolished, have to be temporarily moved out of the house for house repair.	Support on removal costs and rental fee shall be 50% of support level in section 4.1 and 4.3. Three (03) months rental fee shall be provided.
5. Resettlement support	5.1 Households and individuals who opted for relocation site.	+ Those who receive residential land, or apartment for resettlement but the amount payable to obtain the residential land or house for resettlement is more than the value of the minimum quota, the difference should be paid by the households and individuals. + Those who receive residential land or house for resettlement but the amount payable to obtain land, housing is less than the minimum quota, they are entitled for the difference in cash.
	5.2 Removing households and individuals who can arrange places of residence by themselves.	+ Cash equal to the difference between infrastructure investment with the entitled compensation and support amount of money. PLUS + Cash equal to the value of infrastructure investment.
6. Support for agricultural land in residential area and garden and pond	6.1 Households and individuals having garden or pond in the same land lots with house in residential areas which is not recognized as residential land; garden or pond in the same land lot with separate houses; garden or pond in the same land lot with houses along canals, ditches or roads.	In addition to compensation for the value of the agricultural land, a support equal to 50% of the value of residential land of those land lots. Area eligible for support is equal to land area actually recovered but must not exceed 5 times the land allocation limit specified by DNPPC at the time the plan on compensation and support.

Types of support and compensation	Items to be compensated and supported	Compensation and Support level
land not recognized as residential land. Note: Agricultural land; garden and pond specified in section 6.1 and 6.2 shall not be entitled for support under Stem 8.1	6.2 Households, individuals having agricultural land within the administrative boundaries of wards, in residential areas within townships or in rural residential areas; agricultural land lots adjacent to the boundaries or wards or residential areas. **Note:** The house must not violate publicized land use planning and provisions in paragraph 4 of Article 14 of Decree No. 84/2007/ND-CP dated May 25, 2007, are entitled with this support policy.	In addition to the compensation for the value of the agricultural land, a support equal to 35% of the average price of residential land. Area eligible for support is equal to land area actually recovered but much not exceed 5 times the land allocation limit specified by DNPPC at the time the plan on compensation and support
	6.3 Where rate of compensation and support for agricultural land; gardens, ponds in Section 6.1 and 6.2 is higher than the land compensation rate.	Only be compensated and supported at the corresponding land price.
7. Support for living and production stabilization	When the State recovers agricultural land (including garden, pond and agricultural land specified in Section 6.1 and 6.2)	**Note**: Level of support for a person for one month is the cash equivalent to 30 kg of rice at the average price at the time the support is provided.
	a. Those having 30-70% of the agricultural land area under use recovered.	Life stabilization for 06 months if they are not required to move out, or 12 months if they are required to do so. If they have to move to areas with socio-economic difficulties or extreme difficulties, the maximum support duration is 24 months.
	b. Those having over 70% of the agricultural land area under use recovered.	Life stabilization for 12 months if they are not required to move out, or 24 months if they are required to do so. If they have to move to areas with socio-economic difficulties or extreme difficulties, the maximum support duration is 36 months.
	c. Economic entities, production and business households with their business registered, have to suspend production and business activities.	Entitled to the support of 30% of one year’s post tax income, calculated based on three preceding year average income as certified by tax agency.

Types of support and compensation	Items to be compensated and supported	Compensation and Support level
	d. Households and individuals using land allocated under contract for agricultural, forestry or aquaculture purposes (excluding land for special-use forests, protection forests) with state-run agricultural and forestry farms who are employees of those farm and are working, having retired, have ceased working due to working capacity loss or receiving severance allowance and are directly engaged in agricultural or forestry production; and contracting households individuals directly engaged and living mainly on agricultural production.	Entitled to support in cash. Support level equals to 75% of land value calculated based on the actual recovered land area which, however, must not exceed the agricultural land allocation limit specified in Article 70 of Land Law in 2003.
	e. Households and individuals receiving compensation in agricultural land (non-cash compensation).	Support for production stabilization, including plant varieties and animal breeds for agricultural production; agricultural and forestry extension services, plant protection and veterinary services, cultivation and animal husbandry techniques, and professional techniques for production, and business provision.
8. Support for job change and creation	8.1. When the State recovers agricultural land not specified in sections 6.1 and 6.2 but no land is available for compensation, households and individuals directly engaged in agricultural production are entitled to:	In addition to compensation in cash as prescribed in Clause 1 of Article 16 of Decree No. 69/2009/ND-CP, support for job change or creation in cash, residential land, house or non-agricultural production and business land as follows: a. Cash support equal to 1.5 times the agricultural land value for the whole recovered agricultural land. The land eligible for support must not exceed the land allocation limit in the locality. b. Single support equals to one residential land ration, one condominium apartment or on ration of non-agricultural production and business land. This form of support applied in localities having residential land funds and house funds and to support beneficiary wishing to have residential land, condominium apartment or non-agricultural production and business land while the support value under item (a) above is more than or equal to the value of residential land, condominium apartment or non-agricultural production and business land. Cash support will be provided for the difference in vlaue.
	8.2 Support beneficiaries defined in section 8.1 that need vocational training.	Provision of enrolling in job training establishments. Those of working age are entitled to attend one training course free of charge.

Types of support and compensation	Items to be compensated and supported	Compensation and Support level
9. Support for special conditions	9.1 If households of Vietnamese heroic mothers, war invalids, sick soldiers, and martyrs' families are acquired: (i) all agricultural land or residential land shall be acquired and (ii) all small production business premises and all of the residential land area shall be acquired.	In addition to support under provisions, they are entitled to further support as follows: a. VND 20,000,000 per household to the Viet Nam heroic mothers, war invalids (1/4 invalid level or more), sick soldiers of third rank or higher and martyrs' families. b. VND 15,000,000 per household for soldiers with a disability ratio between 61% - 80%. c. VND 10,000,000 per household for soldiers with a disability ratio between 21-60%:
	9.2 Households with poverty, ethnic minorities who directly engaged in agricultural production, and whose agricultural land, residential land shall be acquired; remain small business, no premises for business and production and acquired all of land area.	VND 10,000,000 per household.
10. Support for tuition, medical services	10.1 Support tuition for children of resettled households when the Government carries out land acquisition.	+ Preschool pupils: tuition fee exemption for the first two years of study. + Elementary school students: priority admission to public primary schools + Secondary school students, high school and post-secondary/high school students: Exemption of school fees for the first two years.
	10.2 Support health services for people who are subject to resettlement.	Shall be granted a voluntary medical insurance card with value of VND 320,000 per person for a period of 12 months.
11. Support tenants whose rental houses are not owned by the State when the State acquires land	Households and individuals living in house rented from non-state owner and having house lease contract in accordance with the law before the notification of land acquisition, have to move when the State recovers the land, are entitled to:	Removal cost (see Section 4.1, a, b, c)
12. Cash support for households, individuals whose large area of land is recovered	Households, individuals are eligible for additional compensation for large land acquisition. **Note:** Households, individuals to be supported under provisions of job change and job placement in Sec 5 shall not be subject to support in this section.	+ Households whose acquired land area is 2.000-1.000m^2 in Bien Hoa City: 25% of the value of infrastructure investment. + Households whose acquired land area is 2.000-3.000m^2 in Bien Hoa City: 50% of the value of infrastructure investment.

Types of support and compensation	Items to be compensated and supported	Compensation and Support level
13. Other supports proposed by the project owner	In addition to supported policy prescribed by DNPPC, the project owner may request for additional support aimed at ensuring the rights and interests of households.	Specific support level for this case shall be proposed by the project owner.
14. Removal of graves	Households and individuals having graves on land recovered, have to relocate these from the existing places.	Compensation shall be paid for expenses for land, digging, exhumation, moving, re-building and other direct related reasonable expenses at the cost prescribed by Dong Nai PPC.
15. Rewards for obeying land acquisition law	Organizations, households and individuals receiving compensation and delivering land on time as prescribed by the organization in charge of compensation shall be rewarded with bonuses calculated according to the total cumulative amount of compensation and support as follows:	+ VND < 10 million: VND 1,000,000 + VND 10-20 million: VND 2,000,000 + VND 20-50 million: VND 4,000,000 + VND 50-100 million: VND 6,000,000 + VND 100-200 million: VND 8,000,000 + VND 200-300 million: VND 10,000,000 + > VND 300 million: VND 12,000,000
16. Compensation for cultural works, historical relics, churches, communal houses, pagodas, shrines	Households and individuals having cultural works, historical relics, churches, communal houses, pagodas, shrines,	Compensation for centrally and locally managed works shall be decided by the Prime Minister and the provincial-level People's Committee chairman respectively

It is recommended that a more flexible entitlement matrix be prepared for this Project in light of World Bank guidelines as explained in Section 11.3.4.

11.5.5 Determination of Compensation Amount

The RAP document should include detailed calculations of the compensation and support amounts.

Compensation amounts shall be decided based on: (i) level of compensation and supports applicable to each household and (ii) unit price of land, structures/buildings, tree, crop, etc.

Level of compensation and support for each affected household will be determined based on regulations prescribed in Decree nos.: 197, 69, 84 and Circular No: 14/2009/TT-BTNMT and DNPPC Decision nos.: 20, 21/2010/QD-UBND and any other related legal document.

Unit price of land within Dong Nai Province is issued annually by DNPPC while the unit price of properties, tree, crops, etc. are issued by related agencies.

Compensation price of land plots will be calculated following instructions given in Circular No: 145/2007/TT-BTC issued by Ministry of Finance dated 6 December 2007. The compensation price is equal to the base price (based on pre determined unit price revised annually) plus an additional amount. The additional amount is included to cover surrounding infrastructure and development prospects. The additional amount is calculated using one of the following methods: (i) direct comparison, (ii) income, (iii) subtraction, (iv) surplus, and (v) special conditions.

It is recommended that the compensation prices reflect the replacement cost.

11.5.6 Public Consultations

Consultation and participation is a process through which stakeholders influence and share control over development initiatives, and the decisions and resources that affect them. It is a two way process where the executing agencies, policy makers, beneficiaries and affected persons discuss and share their concerns. The international development financiers' safeguard policies give high priority on public consultation and participation to strengthen the community voice and assure incorporation of the community's views in design and implementation of a socially and environmentally compliant project.

Attempts should be made during RAP preparation to encourage consultation and participation of the affected people and communities and incorporate their views, needs and aspirations into the Project components. The stakeholder's views should be summarized in the RAP document. It should also be required to mention how these opinions are incorporated in the decision making process.

JICA Study Team recommends holding more public consultations during the process of compensation calculation and prior to finalizing relocation options.

11.5.7 Grievance Redress Mechanism

A RAP document should include methods of lodging complains and the process for their settlement.

Recent Vietnamese laws give specific procedures and measures for the grievance redress. Settlement of complain regarding the decisions on compensation follows the Article 138 of the 2003 Land Law, Article 40 of Decree No. 69/2009, Decree No. 136/2006, and Article No. 63 and 64 of Decree No. 84/2007. Among these, Article No. 63 and 64 of Decree No. 84/2007 are most comprehensive. The laws mention that any person with related interests and obligations can lodge legal complains; thus virtually allows the persons living without legal title and even NGOs or advocacy groups to avail the grievance redress mechanism. A brief description of these 2 articles is given below.

Article 63: Order of settlement of complaints about administrative decisions and duties of district level People’s Committee

i. Within ninety (90) days from the date a district level People’s Committee issues an administrative decision or take an administrative act related to land administration defined in Article 162 Decree No. 181/2004/ND-CP, a person with related interests and obligations who disagrees with that administrative decision or act may file a written complaint with the district level People’s Committee.
ii. The district level People’s Committee chairman shall settle complaints within the time limit prescribed in the Law on Complaints and Denunciations. Settlement decisions issued by the district level People’s Committee chairman must be publicly announced and sent to the plaintiffs and other persons with related interests and obligations.
iii. Within forty five (45) days from the date of receipt of the resettlement decision of the district level People’s Committee, a person who disagrees with that settlement decision may file a lawsuit with a People’s Court or lodge a complaint with the provincial People’s Committee.
iv. For a complaint filed with the provincial level People’s Committee, the provincial level People’s Committee chairman shall settle it within the time limit prescribed in the Law on Complaints and Denunciations. Complaint settlement decisions issued by the provincial level People’s Committee chairman must by publicly announced and sent to the plaintiffs and other persons with related interests and obligations.

Article 64: Order of settlement of complaints about administrative decisions and acts of provincial level People’s Committee

i. Within thirty (30) days from the date a provincial level People's Committee issues an administrative decision or take an administrative act related to land administration defined in Article 162 Decree No. 181/2004/ND-CP, a person with related interests and obligations who disagrees with that administrative decision or act may file a written complaint with the provincial level People's Committee.

ii. The provincial level People's Committee chairman shall settle complaints within the time limit prescribed in the Law on Complaints and Denunciations. Settlement decisions issued by the provincial level People's Committee chairman must be publicly announced and sent to the plaintiffs and other persons with related interests and obligations.

iii. Within forty five (45) days from the date of receipt of the resettlement decision of the provincial level People's Committee chairman the complainant who disagrees with that settlement decision may file a lawsuit with a People's Court.

Grievance redress mechanism for this Project is expected to follow the above mentioned regulations. Inspectors of Bien Hoa City shall coordinate with Compensation, Support and Resettlement Committee (CSRC) and advise the Chairman of Bien Hoa CPC on settling the complaints. Similarly, inspectors of DNPPC shall coordinate with Department of Natural Resources and Environment, and other related departments, and advise the Chairman of DNPPC on settling complaints.

It is recommended that local social organizations, including Fatherland Front, Association of Farmers, Youth Union, Trade Unions, Viet Nam Women's Union, and other similar groups should be mobilized to participate in the process of solving affected person's complaints/grievances.

11.5.8 Relocation Sites

The RAP document should include the description of the relocation sites and other options, if any.

As explained before, Bien Hoa CPC is developing 2 land sites and 1 high rise building as relocation sites. As per regulations of DNPPC, the affected households with legal title can select one of the two compensation options: land or cash, which ever is suitable for their requirements.

JICA Study Team recommends considering the following issues:

- It would be better to relocate the PAP to a nearby site, for example, the people at the STP2 site should be moved to Tan Bien site. This will have similar advantages of the original sites, closer to work and community;
- Timely arrangements for regularizing legal tenure and transferring titles to re-settlers;
- Provision of low interest finance for building development;
- Consideration of adequate social services (e.g., schools, health services); and
- Ensuring comparable services to host populations;

11.5.9 Ethnicity, Vulnerability and Gender Issues

It is recommended that special support package should be provided to ethnic minorities, households headed by females, and physically and mentally challenged persons, if such persons are affected.

11.5.10 Implementation Schedule and Budget

The total resettlement related budget should be prepared by calculating the compensation and support. Cost of execution and planning should also be shown.

It is expected that the RAP will include detail implementation schedule and payment procedure.

11.5.11 Institutional Arrangement for Implementation

The RAP document should explain how and who would implement the RAP.

The implementation of resettlement activities requires the involvement of agencies at the provincial, city and ward levels. Responsibilities of DNPPC, Bien Hoa CPC and related bodies should follow the regulations prescribed in Decree No. 197 and 69. Overview of key responsibilities with respect to land acquisition and resettlement for the organizations involved is given below.

Bien Hoa City People's Committee:

i. To direct, organize, disseminate information and mobilize all organizations and individuals involved with compensation, support and resettlement policies and ground clearance according to the land recovery decisions of competent State bodies;
ii. To establish the Compensation, Support and Resettlement Committee (CSRC);
iii. To direct and organize the implementation of the compensation, support and resettlement plans; and approve the compensation, support and resettlement plans according to the responsibility assigned by the DNPPC;
iv. To coordinate with Bien Hoa City divisions and branches to create relocation areas.
v. To settle citizens' complaints, denunciations related to compensation, support and resettlement.

Ward People's Committees:

i. To organize public information dissemination on the land recovery purposes, compensation, support and resettlement polices of the project;
ii. To coordinate with the Compensation, Support and Resettlement Committee in certifying land and property of persons who have their land expropriated;

iii. To create conditions for, the payment of compensation and support money to, and arrange resettlement for, persons who have land acquired, and

iv. To create conditions for ground clearance.

Compensation, Support and Resettlement Committee (CSRC):

i. CSRC shall assist Bien Hoa CPC in making, and organizing the implementation of compensation, support and resettlement arrangement plans.

ii. CSRC is responsible for the accuracy and rationality of inventory statistics, the legality of land, eligibility of property for compensation, and assisting in the compensation, support and resettlement plans.

Division of Urban Management, Bien Hoa City:

i. To provide guidance on the measurement and legality of construction works located on the land to be recovered, for the calculation of compensation and support for the Project.

ii. To verify data relating to house and land.

iii. To assume the prime responsibility for, and coordinate with the functional agencies in determining the positions and sizes of resettlement areas in accordance with the general development planning, and submit them to competent bodies of Bien Hoa City for approval.

Division of Natural Resources and Environment, Bien Hoa City:

i. To guide the determination of measurement, categories, grades and compensation conditions.

ii. To guide the eligibility for compensation; and compensation or support levels.

iii. To assume the prime responsibility for, and coordinate with the Division of Planning and Investment and the Division of Construction in deciding on the area of land to be recovered.

iv. To verify data relating to land and house affected by the Project.

v. To verify and submit compensation, support and resettlement plan to Bien Hoa CPC for approval.

vi. To prepare and submit land recovery document to Bien Hoa CPC for issuance of decisions on land recovery of households and individuals.

Center for Land Development (CLD):

i. To prepare compensation, support and resettlement plan and plans on organization of compensation, support and resettlement; then submit them to Bien Hoa CPC for approval, take responsibility for the accuracy and policy conformity of the CSRP.

ii. To coordinate with ward people's committee to inform and advise households and individuals who have their land recovered on decisions, plans, etc related to compensation, support and resettlement.

iii. To give guidance and respond to land users' inquiries on matters related to compensation, support and resettlement.
iv. Based on approved CSRP, CLD submit request to Bien Hoa CPC for issuance of decisions on compensation, support and resettlement to affected households or individuals.
v. To coordinate with the Project Owner, State Treasury or Bank to make payment of compensation, support and resettlement and to arrange the resettlement.

Project Management Unit (PMU)

i. As the executing agency of the Project, PMU have to coordinate with all parties concerned for timely preparation of resettlement plan and effective implementation of the plan.
ii. Prepare draft resettlement plan and submit to DNPPC for approval.
iii. Make general arrangements, manage and supervise the resettlement process.
iv. Coordinate with CLD for planning and execution.
v. Ensure fund management.
vi. Prepare and execute payment disbursement schedule.
vii. Accounting and auditing of expenses.
viii. Update resettlement and compensation plan and submit to DNPPC for approval.
ix. Coordinate public consultations.

11.5.12 Monitoring and Evaluation

A detail monitoring and evaluation mechanism must be included in the RAP document.

Monitoring is a process of regularly assessing implementation status in relation to agreed schedules, inputs, and expected outcomes. It provides all stakeholders with continuous feedback on implementation. It identifies both the achieved milestones as well as problems encountered. It also enables the taking of timely corrective actions through early identification of problems.

Regular monitoring of the RAP implementation should be conducted by the PMU and by independent external monitoring organization to be hired by the PMU.

Internal Monitoring

Internal monitoring of the implementation will be the responsibility of the PMUs, assisted by the Project consultants. The main indicators that will be monitored are:

i. payment of compensation to DPs according to the compensation policy described in the RAP;
ii. execution of technical assistance, relocation, payment of support, and moving allowances;
iii. delivery of income restoration and rehabilitation assistance entitlements;
iv. public information dissemination and public consultation procedures;

v. adherence to grievance procedures and outstanding issues requiring management's attention; and
vi. completion of resettlement activities reflected by the award of civil works contracts.

PMU will collect such information every month and will submit a quarterly monitoring report to the external funding agency. The internal monitoring reports shall include the following topics:

i. the number of DPs, by category of impact per project component, and the status of compensation payment and relocation and income restoration for each category;
ii. the amount of funds allocated for operations or for compensation, and the amount of funds disbursed for each;
iii. the eventual outcome of complaints and grievances and any outstanding issues requiring action by management;
iv. implementation problems, and
v. revised actual resettlement implementation schedules.

External Monitoring

The general objective of the external monitor is to provide an independent periodic review and assessment of the achievement of resettlement objectives, the changes in living standards and livelihoods, restoration of the economic and social base of the affected people, the organizational effectiveness, impact and sustainability of entitlements, the need for further mitigation measures if any, and to learn strategic lessons for future policy formulation and planning.

JICA would decide if this is a requirement and would mention this in the loan negotiation. In case this is a requirement, PMU will hire an organization for the independent monitoring and evaluation of RAP implementation. It is recommended that final RAP document should include the outline of the independent monitoring and evaluation procedure.

Evaluation

Resettlement evaluation is an assessment at a given time of the impact of resettlement and whether the stated objectives have been achieved. The internal or external monitor will conduct an evaluation of the resettlement process and impacts 6 to 12 months after the completion of all resettlement activities. The evaluation will be made against the baseline socioeconomic conditions prior to the resettlement.

11.5.13 Summary of Recommendations

In sub sections above, JICA Study Team made recommendations which would increase the social acceptability of the resettlement and land acquisition process. Some of the more important issues are summarized here.

- Flexible RAP Planning: PMU is preparing the RAP according to strict government laws and regulation. Nevertheless, flexible resettlement policy is acknowledged in Decree 131/2006. Therefore, it is recommended that the RAP be prepared in a flexible manner.
- Baseline socio-economic data: It is recommended that a socio-economic survey be conducted for better understanding of baseline socio-economic status of the affected households.
- Public consultations: JICA Study Team recommends holding more public consultation during the process of compensation calculation and prior to finalizing relocation options.
- Compensation calculation: It is recommended that compensation be paid on 'replacement cost' basis.
- Non-titled land users: According to VN regulation, asset attached to land without title shall not be compensated. However, as per principle of World Bank on involuntary resettlement it is recommended that, affected households without legal or eligible land use rights should also get assistance. VN Decree 69/2009, Article 14 allows payment to such non title holders on a case by case basis. JICA Study Team recommends considering this issue in this Project's resettlement, support and compensation plan.
- Crop loss: According to the Viet Nam law, the compensation for lost crops is provided when at least 30% of the agricultural land is acquired. It is recommended that compensation should be given even when the acquired area is less than 30%.
- Agricultural land: It is recommended that for agricultural land-for-land compensation, land of equal productive capacity should be given.
- Income loss: As per Decision No. 20/2010/QD-UBND, the compensation policy allows compensation for registered businesses only. For this Project, it is recommended that all affected households should be compensated for income loss as a result of disruption of business due to the Project, to help restore living standards to pre-project levels.
- Relocation area: It would be preferable to relocate the PAP to the nearby site.
- Financial assistance: Low interest finance for building development should be provided.
- Vulnerable groups and ethnic minorities: Article 8 Decision No. 20/2010/QD-UBND acknowledges the need to provide poor households additional assistance but does not explicitly recognize other vulnerable groups like, households headed by females, elderly, or disabled persons, etc. For this Project, it is recommended that specific measures be defined to ensure that all affected vulnerable groups are assisted to improve or at least restore living standards to pre-project levels.
- Involvement of civic society: It is recommended that local social organizations, including Fatherland Front, Association of Farmers, Youth Union, Trade Unions, Viet Nam Women's Union, and other similar groups be mobilized to participate in the process of solving affected person's complaints/grievances.

11.6 Review of Ongoing Resettlement Activities

11.6.1 Proposed Schedule of Resettlement Activities

The resettlement and land acquisition activities for the proposed STP2 site were initiated in August 2010, in compliance with the Decision 21/2010 as explained in Section 11.3.3. For other proposed construction sites such as the PS1 and canal improvement, the activities are expected to start in the second quarter of 2011. A RAP framework document was prepared by PMU in February 2011 and approval from DNPPC is pending.

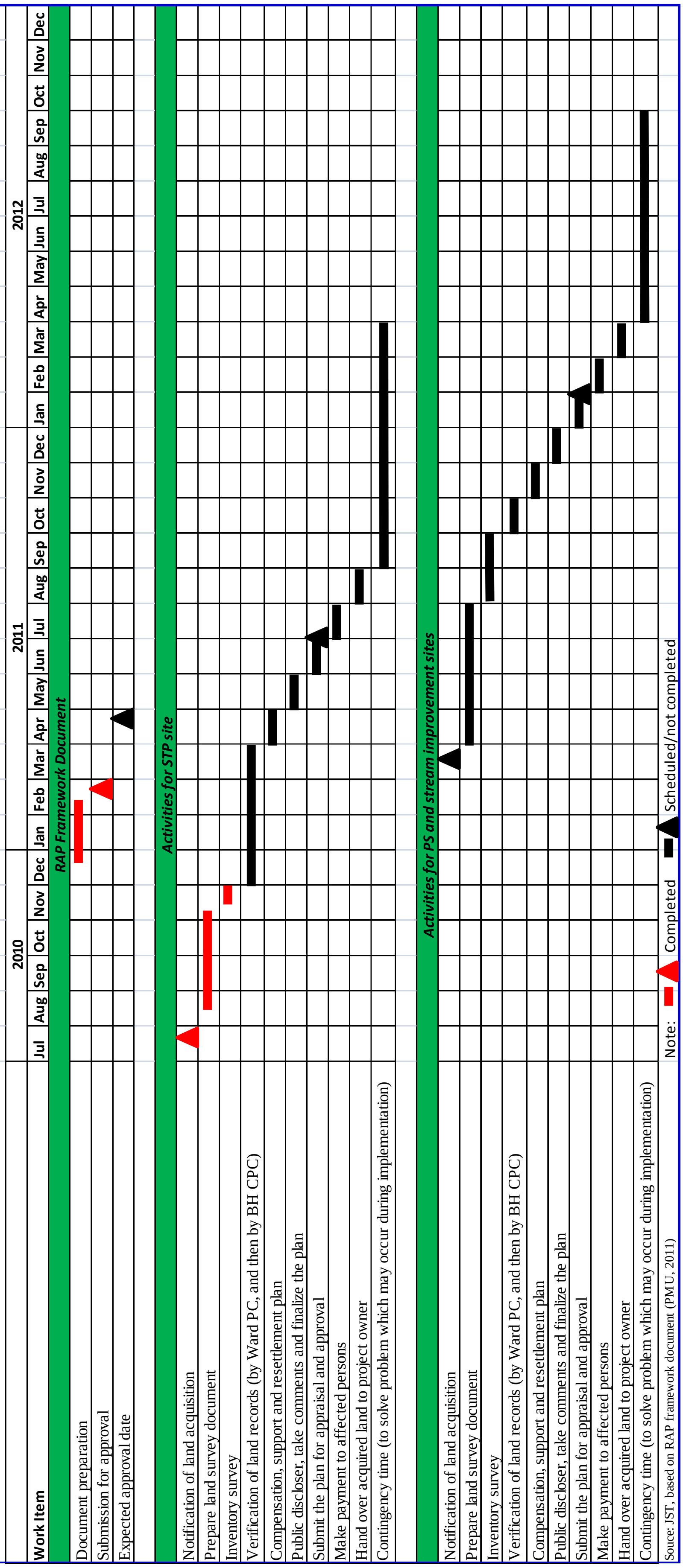
According to the RAP Framework document submitted to DNPPC in February 2011, the proposed activity schedule is given below.

Table 11.6.1 Proposed Resettlement Activity Schedule

Activities	Time	Comment
Schedule for STP 2 Site		
Notification of land acquisition	Completed	Jul. 2010
Prepare land survey document	Completed	Nov. 2010
Inventory survey	Completed	Dec. 2010
Verification of land records (first by Ward PC, and then by Office of Land Use Right Registration (under Division of Natural Resources) and Division of Urban Management)	Mar. 2011	Not completed, expected Apr. 2011
Compensation, support and resettlement plan	Apr. 2011	
Public discloser, take comments and finalize the plan	May 2011	
Submit the plan for appraisal and approval	Jun. 2011	
Make payment to affected persons	Jul. 2011	
Hand over acquired land to project owner	Aug. 2011	
Contingency time (to solve problem which may occur during implementation)	Sep. 2011 – Mar. 2012	
Schedule for PS 1 and Canal Development Sites		
Notification of land acquisition	Mar. 2011	Not completed, expected Apr. 2011
Prepare land survey document	Apr. – Jul. 2011	
Inventory survey	Aug. – Sep. 2011	
Verification of land records (first by Ward PC, and then by Office of Office of Land Use Right Registration (under Division of Natural Resources) and Division of Urban Management)	Oct. 2011	
Compensation, support and resettlement plan	Nov. 2011	
Public discloser, take comments and finalize the plan	Dec. 2011	
Submit the plan for appraisal and approval	Jan. 2012	
Make payment to affected persons	Feb. 2012	
Hand over acquired land to project owner	Mar. 2012	
Contingency time (to solve problem which may occur during implementation)	Apr. 2011 – Sep. 2012	

Source: JICA Study Team, based on RAP Framework document, February, 2011

Figure 11.6.1 Proposed Resettlement Activity Schedule



Souce: JST, based on RAP framework document (PMU, 2011)

11.6.2 Current Status of Resettlement Activities

Major milestones are listed below in chronological order for resettlement activities for the STP2 site.

- DNPPC in its Decision No. 4507/QD-UBND, dated 21 December, 2007 authorized the land requirement (93,420 m^2) in Tam Hiep ward for the STP2.
- Dong Nai PMU for Sewerage project (the executing agency of this Project) submitted a compensation master plan to DNPPC on 22 April, 2010 through letter No. 94/BQLTN. This letter covered 2 STPs, one of which is included in the scope of this Study, namely Tam Hiep STP. Salient features of the plan was
  - ➢ Land requirement is 93,087 m^2 (out of which, residential 22,588 m^2, farm 7,047 m^2, aquaculture 56,195 m^2, road 942 m^2, irrigation canal 6,281 m^2 and streams 32 m^2).
  - ➢ Tentative number of households to be removed is 70 (out of which 57 households will lose entire land while 13 households will lose partial land.)
  - ➢ The calculation basis was 2010 regulation price issued by DNPPC (residential land varied between 3.6 and 5.0 million VND/ m^2)
  - ➢ The total estimated cost was reported as 333 billion VND, however, the estimated cost for Tam Hiep STP cannot be known as the total cost also includes estimated compensation of other STPs.
- Based on a request from DONRE letter 2251/TNMT-DK dated 19 July, 2010, DNPPC made the announcement of land acquisition for the Tam Hiep STP through 6076/TB-UBND DATED 29 July 2010. This letter also assigned the implementation responsibility on Bien Hoa CPC.
- Subsequently, Bien Hoa CPC ordered the Urban management Division, Division of Natural Resource and Environment, the Compensation, Support and Resettlement Committee (CSRC), respective Ward PC, and DN Sewerage and Drainage PMU through letter 2333/UBND-XDCB, dated 18 August, 2010, to initiate resettlement activities. This could be considered as the start date of resettlement and compensation activities for the STP2 site.
- A stakeholders meeting was held on 26 August, 2010 to inform the PAP from the STP2 site regarding the land acquisition and resettlement.
- Bien Hoa CPC established the Compensation, Support and Resettlement Committee (CSRC) for the Tam Hiep STP through Decision 2285/QD-UBND dated 14 September, 2010. The 14 member committee is headed by the Vice Chairman of Bien Hoa CPC and includes 3 representatives of PAP.
- On 11 November, 2010, the Center for Land Development (CLD) issued notice for inventory survey through 485/TTPTQD for the STP2 site.
- The inventory survey was carried out between 16 November and 1 December, 2010 by CLD in cooperation with Ward PC and Project PMU. The survey date will also be considered as cutoff date.

- The survey results for STP2 site were compiled by CLD and submitted to Ward PC by the end of December, 2010.
- The survey documents were being checked against the land records by Tam Hiep Ward PC. This task was completed in March, 2011.
- The Office of Land Use Right Registration (under Division of Natural Resources) and Division of Urban Management are reviewing the documents sent by the Tam Heip Ward PC to confirm the land use right of each plot. It is expected that this task will be completed by April, 2011.

Major milestones are listed below in chronological order for resettlement activities for the PS1 and canal improvement sites.

- Dong Nai PMU for Sewerage project submitted a letter No. 41/BQLTN to DONRE and DNPPC on 17 March, 2011, requesting the announcement on land acquisition for pumping station, and improvement of San Mau, Linh Bayou and Dien Hong streams. Salient features are
  - ➢ Land requirement for pumping station (PS1) is 6,400 m^2,
  - ➢ Land requirement for San Mau Stream is around 137,400 m^2,
  - ➢ Land requirement for Linh Bayou Stream is around 24,400 m^2,
  - ➢ Land requirement for Dien Hong Stream is around 21,700 m^2,

Major milestones are listed below in chronological order for preparation of RAP framework document.

- The PMU and CLD prepared the RAP Framework document in February, 2011 (titled "Plan of Compensation, Support and resettlement, Bien Hoa City Drainage System and WWTP Project – Phase 1") and submitted to DNPPC for approval (Letter 33/BQLTN, 28th February, 2011).

Preliminary estimation of the extent of land acquisition and resettlement is shown below.

Table 11.6.2 Extent of the Land Acquisition and Resettlement

Components	Land Acquisition (m^2)	Full Acquisition (households)	Partial Acquisition (households)
STP	93,000	75*1	13*1
PS	6,400	0*2	0*2
Canal Development	183,500	App. 75*3	App. 900*3

Note: *1 = Preliminary result from the inventory survey, to be validated by Office of Land Use Right Registration.
*2 = There is no legal land title holder in the area for pumping station.
*3 = PMU Estimation, inventory survey for the canal development has not been started yet.

Source: JICA Study Team, based on RAP Framework document, February, 2011

11.6.3 Implementation Review

Center for Land Development (CLD) has been assigned to carry out resettlement related activities. Their scope includes carrying out activities such as public consultation, inventory survey, preparation of RAP framework document, preparation of compensation plan, and assisting in making payment. Functions, duties, authorities, organization structure and financing mechanism of CLD are regulated by the Joint Circular No. 01/2010/TTLT-BTNMT-BNV-BTC dated January 8, 2010, issued by Ministry of Natural Resources and Environment, Ministry of Interior and Ministry of Finance. CLD is a standing organization under the management of Bien Hoa CPC to work under the Compensation, Supports and Resettlement Committee (CSRC) on the implementation of resettlement related activities for projects in Bien Hoa City and other districts and towns of Dong Nai, until other districts establish their own equivalent agencies.

The inventory survey for the STP2 site was completed in December 2010. The survey questionnaire was divided into 2 main parts, namely, house and property; and other assets such as electricity meters, trees and crops. The survey measured the land area and marked the location on a map. It collected information on building measurements and building types. The inventory survey also counted different types of the trees. The preliminary results of the survey show that there are 88 properties affected.

After the inventory survey, the contents were compared with the land records by the Ward PC to establish the legal right. The results of the survey were sent to Bien Hoa CPC for verification. The verification is to be carried out by the Office of Land Use Right Registration (under Division of Natural Resources) and Division of Urban Management.

At the time of preparation of this report (April, 2011), the verification of the inventory data by Bien Hoa CPC is ongoing. According to the RAP framework document, it was supposed to be completed in March, 2011 (ref. Table 11.6.1). However, due to irregularities in some land records, it is delayed. According to PMU, it would be completed in April, 2011.

Based on this verified information, CLD will develop a plan for compensation and support following government rules and regulations. The plan will be publicly posted at the ward office and public comments will be received. Accordingly the plan will be finalized. The said plan will then be submitted to Bien Hoa Division of Natural Resources and Environment for evaluation. The evaluation committee will be comprised of representatives from the Division of Natural Resources, Division of Finance and Division of Construction. After that, the plan will be submitted to Compensation, Support and Resettlement Committee (CSRC) for approval. Finally, it will be submitted to Bien Hoa CPC for final approval. After the approvals, payments will be made to the affected persons.

Similar procedure will be adopted for the resettlement activities for PS1 and canal development. According to the RAP framework document, the notification of land acquisition would be issued by March. 2011. As of April 2011, it was not been issued. As mentioned before, PMU submitted a letter requesting the notification to DNPPC through DONRE on 17th March. According to PMU, they expect that the notification would be issued by April, 2011.

11.6.4 Comments on Current RAP Document

JICA Study Team provided recommendations on RAP document preparation in December 2010, which are summarized in Section 11.5 of this Report. JICA Study Team recommendations were prepared in compliance with the JICA requirements (identified in the consultant TOR) and World Bank manual OP 4.12 Annex A. Subsequently, PMU prepared a RAP document with support from Center for Land Development (CLD). The document was submitted to DNPPC for approval through the Letter 33/BQLTN, 28th February, 2011. The document is attached as appendix of this Report. JICA Study Team reviewed the document and the findings are summarized in the following.

1. Description of Project

Both JICA Guideline and WB OP4.12 Annex-A require the Resettlement Plan to describe the proposed project components and its geographic, ecological, social and temporal context, including any off-site investments that may be required (e.g. dedicated pipelines, access roads, power plants, water supply, housing, raw material and product storage facilities, relocation sites, etc.). It normally includes a map showing the project site and the area affected. In addition, components needing land acquisition and resettlement should be clearly mentioned.

The prepared RAP document includes the section of project description (Sec I.6 and I.7) but some of the facilities are different from the proposed Project (for example, the capacity of STP2 is now proposed as 52, 000 m^3/d). Also, some of construction plans are also different (for example, large diameter pipes is now proposed to be constructed by pipe jacking method). Further, there is no clear indication of components needing land acquisition and resettlement. Section 11.2 of this Report can be referred to for such information.

2. Potential impact (including study to minimize the resettlement)

World Bank's OP 4.12, Annex-A (Art. 4) requires Resettlement Plan to specify the project's potential impacts covering: (a) the project component or activities that give rise to resettlement; (b) the zone of impact of such components or activities; (c) the alternatives considered to avoid or minimize resettlement; and (d) the mechanisms established to minimize resettlement, to the extent possible, during project implementation.

The prepared RAP document specifies (sec II): (i) project affected people; (ii) main impacts caused by the Project; (iii) steps to minimize negative impacts; and (iv) measures to minimize resettlement. The document provides losses and the extent relating to resettlement (Tables 1 to 3). However, inventory survey was completed only for STP2 at the time of RAP document preparation. Losses were mostly estimated based on the approved Basic Design Report (2008).

To make RAP compatible with JICA and World Bank requirements, it should be prepared following "Section II: Components of a Resettlement Action Plan - Identification of Project

Impact and Affected Population - Handbook for Preparing a Resettlement Action Plan" (International Finance Cooperation, IFC, 2002).

3. Objectives

The main objectives of the resettlement program have been properly specified in the prepared RAP document in Section VI.1.

4. Socio-economic study (including asset inventory)

In the prepared RAP document, there is a section (Sec IV) on socio-economic conditions, which only mentions socio-economic conditions of Bien Hoa City. There is no specific socio-economic conditions for the Project impact areas. In this JICA Report, JICA Study Team provided ward by ward socio-economic conditions of the Project area and when applicable, JICA Study Team also provided Living Quarter data where the construction (and resettlement) will take place.

The asset inventory survey has been completed for the STP2 site and similar survey is planned for the PS1 and canal improvement sites. However, no socioeconomic data had been collected in the inventory survey such income and income source, education, ethnicity, etc. It is recommended that during the inventory survey for the PS1 and canal improvement, such baseline socioeconomic information be collected.

In principle, a baseline socio-economic survey should be conducted for the Project service area and the relocation host area. Several years after project completion, another survey should be conducted and the result should be compared with the baseline survey.This will help to evaluate the status of the affected persons after the resettlement. The prepared RAP document Sec X.4, states that, "it is necessary to conduct socioeconomic surveys before the implementation of compensation plan as well as during and after the implementation so as to compare the success or failure of the plan". JICA Study Team recommends that PMU comply with this proposal.

5. Legal framework

A Resettlement Plan should provide findings of the analysis of the legal framework in the country. To assist PMU, JICA Study Team review all relevant Vietnamese laws, regulations and policies and conducted an analysis (Ref. Sec. 11.3.1, 11.3.2 and 11.3.3). The prepared RAP document listed relevant laws and regulations of Viet Nam Government and DNPPC in Sec. III.

6. Institutional framework

World Bank OP 4.12, Annex A (Art. 8) requires Resettlement Plan to specify findings of an analysis of the institutional framework covering;

- (a) the identification of agencies responsible for resettlement activities and NGOs that may have a role in project implementation;

- (b) an assessment of the institutional capacity of such agencies and NGOs; and
- (c) any steps that are proposed to enhance the institutional capacity of agencies and NGOs responsible for resettlement implementation.

In the prepared RAP document, Sec VIII specifies responsible agencies and their responsibilities for the implementation of RAP, including DNPPC; departments of finance, construction, natural resources and environment; Provincial Project Management Unit; Bien Hoa CPC; Centre for Land Development; Ward people’s committees and other concerned agencies. However, no assessment has been made on their institutional capacity and no capacity development steps, if required, has been proposed.

7. Eligibility

Eligibility of those affected by resettlement/ land acquisition is generally shown in a tabular form called “entitlement matrix”. To assist PMU, JICA Study Team provided the matrix in Section 11.5.4. In the prepared RAP document, eligibilities following Vietnamese regulations are mentioned in Sec V.3 and V.4. It is preferable to allow some kind of support for non title holders.

In the prepared RAP document, the cut-off date is mentioned in Sec V.2 as the date of inventory survey.

8. Valuation of and compensation for losses

World Bank OP 4.12 - Annex A (Art. 10) requires Resettlement Plan to specify description of the methodology to be used in valuing losses and to determine their replacement cost; and a description of the proposed types and levels of compensation under local laws and supplementary measures necessary to achieve replacement cost for lost assets.

In the prepared RAP document, Sec. XI.5 indicates the unit prices relevant to the compensation and supports specified by decisions of DNPPC. According to the schedule mentioned in the RAP document, CLD will develop plan on compensation, support and resettlement after the confirmation and verification of the inventory survey (Refer to Table 11.6.1). Since it is not possible to include such information until the completion of the survey activities, JICA Study Team recommends attaching the plans (one for STP2 site and the other for the PS1 and canal improvement) to the current RAP document when they are ready.

9. Resettlement measures

World Bank OP 4.12 Annex-A (Art. 11) requires that the Resettlement Plan specify a description of the packages of compensation and other resettlement measures that will assist each category of eligible displaced persons to achieve the objectives of the policy. In addition to being technically and economically feasible, the resettlement packages should be compatible with the cultural preferences of the displaced persons, and prepared in consultation with them.

In the prepared RAP document, Sec. V.3 specifies compensation policy for (a) agricultural land, (b) residential land, assets, (c) fruits, crops, plants, animals, (d) homes and buildings, (e) temporary losses during construction, (f) losses caused by indirect effects, and (g) public properties. Sec. V.4 mentions various support policies including transportation allowance, rental support, supports for livelihood and production stabilization, etc.

Sec VI.3 mentions resettlement measures as: (i) apartment or plot at relocation area; (ii) new plot of similar land use equivalent to the acquired plot; and (iii) cash.

10. Site selection, site preparation land relocation

A Resettlement Plan should specify alternative relocation sites considered and provide explanation for the selection, covering;

- institutional and technical arrangements for identifying and preparing relocation sites,
- explanation of location advantages,
- estimation of time needed to acquire and transfer land and ancillary resources,
- measures necessary to prevent land speculation or influx of ineligible persons to the selected sites,
- procedures for physical relocation under the project, including timetables for site preparation and transfer; and
- legal arrangements for regularizing tenure and transferring titles to re-settlers.

The prepared RAP document has a section on this topic (Sec. VI.4). It briefly mentions the 2 land sites and one apartment block as relocation sites. Though it mentions that all infrastructures will be ready in 2011, there was no mention on the legal procedure of title transfer.

The document also mentions that on 30/12/2010, there was a meeting among DN PMU for sewerage and drainage, Bien Hoa PMU for infrastructure, and other agencies, where all parties proposed to establish 7 more new relocation areas in the next few years.

11. Housing, infrastructure and social services

The prepared RAP document Sec. VI.5 mentions that infrastructures at relocation areas will be upgraded making it comparable with or better than the old sites. Social services such as schools and health services will be available for these relocation areas. However, the plan remains short of mentioning what exact plans have been taken, who will finance and when these will be implemented.

12. Environmental protection and management

World Bank OP 4.12, Annex-A, Environmental Protection and Management (Art. 14) requires Resettlement Plan provide description of the boundaries of the relocation areas and an assessment of the environmental impacts of the proposed resettlement and measures to mitigate and manage these impacts.

The prepared RAP document Sec. VI.6 briefly mentions that there will be sewer collection system in the new relocation area and solid waste will be managed by URENCO. However, the RAP document did not provide any assessment of the environmental impacts of the proposed resettlement and measures to mitigate and manage these impacts, if any.

13. Community participation and possibility of public integration

Sec. IX of the prepared RAP document properly indicates objectives of public consultations, importance of public consultation during Project preparation, public participation, public meetings, Project booklets, and public posting of resettlement plan. This arrangement is compatible with international norm.

JICA Study Team received confirmation from the people living at the proposed STP2 site that they were aware of the land acquisition since 2007, when DNPPC authorized the land acquisition for the proposed STP2. This is likely because all important notices are posted on the information board at Ward Office.

The first formal series of public consultations were started by the PMU in November 2009 as instructed by the letter 3032/UBND-XDCB issued by Bien Hoa CPC on 9 November, 2009. The main purpose of that series was to inform the city people about the whole project. PMU arranged such consultation meetings in 15 wards between November 2009 and January 2010.

The notice of land acquisition for the STP2 site (issued 29 July, 2010) was also posted on the notice boards at the ward office and mentioned over radio. A stakeholder meeting was arranged on August 26, 2010 to explain the resettlement process. That meeting also selected 2 PAP representatives to be included in the Compensation, Support and Resettlement, Committee (CSRC).

It is expected that the result of the inventory survey and later, the compensation amount will be publicly announced. Any comments, requests or claims from affected household will be clearly explained, discussed through meetings at ward PC.

According to the prepared RAP meeting, there will be at least one public consultation meeting after the final list of affected people is prepared. JICA Study Team recommends that there should be another public consultation meeting after the preparation of compensation plan, so that people can express their opinions on the compensation model and amount and these could be reflected in the revised compensation plan before being approved by the competent authority.

14. Integration with host populations

World Bank OP 4.12, Annex-A, Integration with host populations (Art. 16) requires outlining measures to mitigate the impact of resettlement on host communities, including

- (a) consultations with host communities and local governments;
- (b) arrangements for payments to the hosts for assets provided to re-settlers;
- (c) arrangements for addressing conflicts that may arise between re-settlers and host communities; and
- (d) measures necessary to augment services (e.g., education, water, health, and production services) in host communities to make them at least comparable to services available to re-settlers.

The prepared RAP document Sec. VI.7 and VI.5 mention very briefly that such integration will be made. However, there was no plan of consultations with the host community, no arrangement proposed for conflict resolution between re-settlers and the host community, and no specific proposal to improve the living conditions of the host community.

15. Grievance procedures

An important aspect of any RAP document is the grievance redress mechanism for third-party settlement of disputes arising from resettlement. To assist the preparation, JICA Study Team summarized the procedure based on the Vietnamese regulation in Section 11.5.7. In the prepared RAP document, this issue is elaborated in Sec. IX.7. The four step mechanism starts with Ward PC, followed by City PC and Provincial PC. The last resort is the civil court. However, the RAP document does not mention administration and legal fees for claim lodgment, subsequent proceedings, document and record retrieval, etc.

16. Organizational responsibilities

This issue is closely related to Item 6: Institutional Framework. World Bank OP 4.12, Annex A, Organizational responsibilities (Art. 18) requires that the organizational responsibilities should be clarified for the agencies related to the implementing the resettlement. To assist PMU, JICA Study Team carried out such exercises which are given in Sec. 11.5.11. In the prepared RAP document, Sec. VIII specifies responsible agencies and their responsibilities for the implementation of RAP.

17. Implementation schedule

A Resettlement Plan should describe an implementation schedule covering all resettlement activities from preparation through implementation, including target dates for the expected payment to re-settlers and hosts, and termination dates for all forms of assistance. The schedule should indicate how the resettlement activities are linked to the implementation of the overall project.

In the prepared RAP document, implementation schedule is explained in Sec. VII. The section also indicated all resettlement activities from preparation (notice on land allocation) to implementation (payment of compensation and hand over the land to project owner) and the target dates. The schedule also shows the contingency period for resolving any dispute. According to the proposed schedule, resettlement related activities for STP2 will end by March 2012 and those for the PS1 and canal development will end by September 2012. A modified schedule is given in Table 11.6.1 of this Report.

However, RAP Implementation Plan has not indicated how the resettlement activities are linked to the implementation of the overall project.

18. Cost and budget

As required by World Bank OP 4.12: Annex A - Cost and Budget (Art. 20), a Resettlement Plan should indicate tables showing itemized cost estimates for all resettlement activities, including allowances for inflation, and other contingencies, timetables for expenditures, sources of funds, and arrangements for timely flow of funds.

Sec. XI of the prepared RAP document describes the expenditures and budget. It also explains the basis of the expenditures and budget, as shown in the following:

- The fund for implementation of resettlement plan shall be allocated from DNPPC to PMU and PMU shall be responsible for allocation of the fund to Center for Land Development (CLD). CLD will be responsible for making payment directly to the affected households.
- The unit price of compensation and support will be adjusted on a yearly basis according to directives issued by DN PPC.
- Unit costs for land will be calculated based on Decision No. 79/2010/QD-UBND issued by DNPPC dated 24 December 2010
- Unit costs for trees, plants, crops, associated structures and other assets will be calculated based on Decision No. 30/2008/QD-UBND issued by DNPPC dated 14 April 2008.
- Allowances and support will be calculated based on Decision No. 20/2010 /QD-UBND issued by DNPPC dated 05 April 2010.

JICA Study Team recommends that yearly inflation be considered on the unit price of trees, plants, crops, associated structures and other assets, since the 2008 price used is rather old.

Total estimated cost for RAP implementation is 404 billion VND, equivalent to around 21 million USD (exchange rate 1 USD = 18,932 VND), which includes resettlement costs, support costs, implementation administration cost and contingency. The resettlement related cost for STP2 site is 152 billion VND and that for the PS1 and canal improvement is 252 billion VND.

It should be noted that the quantities used for the cost estimate were based on Basic Design Report (2008) and there would be significant change since that time. According to the implementation schedule proposed in the RAP document, updates of the compensation plan will be prepared after the completion of the inventory survey. Scheduled dates for preparation of updated plans are April 2011 for STP2 and November 2011 for PS1 and canal improvement (Refer to Section VII.2 of the RAP document and Table 11.6.1 of this Report). Approval dates of the compensation plans are scheduled for June 2011 and January 2012, respectively.

JICA Study Team recommends that PMU make those 2 compensation plans available to JICA at or before the time of project evaluation for potential ODA funding.

19. Monitoring and evaluation

Consistent with requirement given in World Bank OP 4.12 - Annex A - Art. 21: monitoring and evaluation, JICA Study Team provided an example in Sec. 11.5.12 of this Report. In the prepared RAP document, Section X provides: (i) objectives of monitoring and evaluation, (ii) internal monitoring and supervision, and (iii) external monitoring and evaluation. This also indicates reporting mechanisms; monitoring and evaluation indicators.

11.6.5 Further Recommended Activities

The RAP document prepared by the PMU generally complies with most of the requirements of Vietnamese regulations and international norms however there are a few improvements that can be made. A complete RAP document should include summary results of the inventory survey (to identify exact extent of land acquisition and resettlement requirements) and summary results of the compensation plan (to indicate the cost estimate based on exact land acquisition and resettlement requirements and other support programs). It should be noted that the actual cost may vary during project implementation.

The current RAP document does not include exact quantities of land acquisition and resettlement because the inventory survey for the PS1 and canal improvement has not started yet. As a result, the cost estimate is also preliminary in nature. As mentioned in the RAP document the final compensation plan (including the final cost estimate based on exact land acquisition and resettlement/ support scope) will be prepared after the completion of the inventory survey.

Scheduled dates for preparation of these plans are April 2011 for STP2 and November 2011 for PS1 and canal right-of-ways. Planned approval dates for the compensation plans June 2011 and January 2012, respectively. (Refer to Table 11.6.1).

JICA Study Team further requests the PMU that during the modification of current RAP framework document and preparation of 2 compensation plans, all the recommendations and suggestions provided in Section 11.5 should be taken into consideration and should be reflected in the final documents.

The JICA Study Team also recommends that the PMU make the compensation plans available to JICA at or before the time of project appraisal for ODA finance.

CHAPTER 12 PERFORMANCE INDICATORS & MONITORING

12.1 Performance Indicators

Performance indicators are recommended to monitor and evaluate progress in achieving the intended benefits of the Project.

The following performance indicators are proposed for sewerage:

- volume of sewage treated,
- population served,
- number of house connection,
- percentage of the population served in the priority area, and
- quality of treated effluent.

The following performance indicators are proposed for drainage:

- For sewer served locations: the area affected by flooding for rainfalls with intensity equal to or less than 57.0 mm/hr (1-year return period).
- For improved canals: the area affected by flooding for rainfalls with intensity equal to or less than 80.0 mm/hr (5-year return period) when water levels in the rivers are not a contributing factor.

12.2 Performance Target

Targets for the proposed indicators are determined according to the nature of the project and should generally be achieved 2 or 3 years after the project becomes operational. The project is expected to achieve its intended targets by year 2011. Performance indicators and proposed targets for Project Phase I are indicated in Table 12.2.1.

Table 12.2.1 Performance Indicators and Targets

Indicator	Present (year 2011)	Target (year 2021)
Volume of Sewage Treated (m^3/d)	0	41,500
Population Served (Persons)	0	188,000
Number of House Connection (Households)	0	28,700
Percentage of the Population Served in the priority area(%)	0	100
Quality of Treated Effluent	BOD_5: － SS : －	BOD_5 ＜30mg/L SS ＜30mg/L
Sewers: Flooded area for rainfall with intensity of less than 80.0 mm/hr (5-year return period)	130 ha	0 ha
Canals: Flooded area for rainfall with intensity of less than 57.0 mm/hr (1-year return period)	110 ha	0 ha

12.3 Measurement of Performance Targets

The volume of sewage treated would be measured automatically at the inlet of the STP. Served population would be estimated from the recorded number of house connections and percentage of population served would be calculated on the basis of official population data for each ward. Quality of treated effluent would be monitored by the treatment plant operator as required for compliance with the discharge permit.

Water quality improvement would be observed in San Mau stream, and Tan Mai Stream. These are not selected as appropriate performance indicators because improvements in water quality cannot be predicted at the moment. It is recommended that the new sewerage and drainage company monitor water quality in streams periodically as indicated in Table 12.3.1. Accumulation data before commissioning of the sewerage system will also help to define any improvements created by the project.

Table 12.3.1 Recommended Monitoring Method for Water Quality of Rivers

River/Channel Water Quality	Monitoring Locations	San Mau stream (3 points), Tan Mai stream (3 points), Dien Hong ditch (3 points), Ba Bot Stream (3 points), Linh stream (1point),:Total 13points
	Parameters for Analysis	pH, Turbidity, Temperature, DO, SS, COD, BOD_5, Total Coliform, Heavy metal
	Sampling Frequency	4 times/month except for Heavy metals (1 time/3 month)

Canal and drainage improvement components of the project should have a measurable effect on reducing flood frequency, water depth, flood duration and the amount of damage incurred per year. However, the effect cannot be quantified and targets cannot be set because flooding is also influenced by water levels in the river and key data such as intensity, duration, and frequency of rainfall as well as historical records of previous floods are not available. It is recommended that the new sewerage and drainage company collect flood data to evaluate the effect of the project. Data should be collected after every flood event in the manner presented in Table 12.3.2 at 5 points selected from the frequent flood areas for canal rehabilitation, and 8 points selected for storm sewer. The accumulation of the data would help to monitor the effect of the project.

Table 12.3.2 Recommended Flood Data Collection Method

Survey locations	One point in each of the following wards: Tan Bien, Quyet Thang, Trung Dung, Thong Nhat, Tam Hoa, Tan Hiep, Hoa Binh, Tan Tien, Ho Nai, Thanh Binh , Quan Vinh , Tam Hiep, Trang Dai
Data	Date, flood depth, area, and duration time
Timing	Immediately after a flood

CHAPTER 13 CONCLUSIONS AND RECOMMENDATIONS

13.1 Sustainability

The sustainability of project benefits would be achieved through: (i) use of innovative technology which is appropriate for the local conditions; (ii) Government's commitment to capacity building for O&M; and (iii) implementation of an appropriate tariff. The lessons learned during project design and implementation would be incorporated in the preparation of any follow-up projects, thereby enhancing the sustainability of the larger initiative in Bien Hoa, if such an initiative is undertaken.

13.2 Risks and Mitigation Measures

Risks to the successful implementation of the project are identified in Table 13.2.1.

Table 13.2.1 List of Risks and Mitigation Measures

Risk	Risk Mitigation Measure
<u>Cost increase</u>: if there are contract variances for building foundations and soil improvement works.	Detailed geotechnical investigations at the design stage including a plate bearing test. The tender documents shall specify the Bidder’s responsibility to do carry out an independent soil investigation.
<u>Cost increase</u>: contract variances for pipe trenching and bedding.	Proper technical specifications shall be prepared to meet project specific conditions.
<u>Cost increase</u>: if there are contract variances for road and railway crossings.	The scope of work and costs will be discussed with local authorities having jurisdictional responsibility. Agreed provisional sums shall be included in the tender documents.
<u>Delay</u> to the start of trunk sewers and treatment plant if the Cai Riverside Road is not constructed before the project begins.	The PMU shall implement an IEC campaign that will include communication and coordination with the agencies responsible for the construction of Cai River Road. Priority shall be allocated to funding the Cai River Road project.
<u>Low inflow</u> of sewage at the treatment plant if households are not connected to the sewer system.	The IEC campaign shall include aggressive promotion of house connections. A special unit will be created within the PMU to manage house connections and provide homeowners with technical assistance. Grants and a revolving loan fund will be provided to every household to help with the cost of making a connection.
<u>Delay</u> in the rehabilitation of canals if land for maintenance and construction access roads is not acquired before the start of the project.	The PMU, the center for land development and the PPC must take appropriate actions in effective and timely manner for clearing project sites before the construction.
Equipment and process malfunctions caused by poor staffing skills, and lack of funding.	Implement a capacity building program for O&M staff including technical assistance with operations for 1 year. Implement an appropriate increase in the environmental protection fee to cover the costs of maintenance and equipment replacement.

13.3 Conclusion

This project will contribute to the reduction of pollution and improved drainage. Benefits include improved public health and sanitation, and increased economic development potential. Downstream beneficiaries include a large population in Ho Chi Minh City that uses the Dong Nai River as a source of potable water. The Project also satisfies the priorities identified in National water sector policies.

The project will cost about $US 667 million and will require a significant investment in the form of bi-lateral aid. The Government of Japan has financed many sanitation projects in Viet Nam and is actively supporting improvements in the environmental sector. Proposed priority project I would be eligible for a Japanese yen loan with the following attractive on-lending rates: interest rate of 0.65%/year over a 40 year loan term, with a 10 year grace period. Financial support from JICA would give the project access to the knowledge base and lessons learned from other Japanese ODA projects as well as on-going technical assistance in the sector.

In consultation with the PMU the study team has prepared two alternatives to reduce the scope and costs of the project if funding becomes a constraint. Project Alternative 1 is US$ 540 million and Alternative 2 is US$ 395. Appendix 13-A provides the details for each alternative. The rehabilitation of canals (except Bien Hung ditch diversion, Dien Hong Ditch and Linh Stream) has been removed from both Alternatives. In both alternatives the area to be serviced by separate sewers is progressively reduced by eliminating areas that are currently less developed.

Although reduced costs may make the project more financially viable, the expected benefits would not be as significant.

13.4 Recommendations

The items listed below should be undertaken during subsequent stages of the study or during the design and implementation periods:

(1) PPC and/or PMU should complete the compensation plan for the STP site before the appraisal mission of any potential donor including JICA.

(2) PPC and/or PMU should start field activities/ inventory survey for the pumping station and stream improvement as soon as possible. After completion of compensation planning for these areas, the outcome should be reported before the appraisal mission of any potential donor including JICA.

(3) PPC and/or PMU should coordinate activities of Cai River Side Road and sewerage projects with relative agencies, and share information with them to avoid potential delays in construction of main trunk sewer.

(4) Detailed geotechnical investigations shall be carried out during the design stage for:

- STP site to confirm the structural requirements for foundations of each structure.
- Pumping stations, and pipe ditches to prepare appropriate temporary works and

foundation, and to select economical and safe construction methods.

- The tender documents shall also specify that the Bidder's are responsible for carrying out an independent investigation of soil conditions.

(5) Preparation of appropriate regulatory arrangements and work procedures for sewerage house connection is recommended at the detailed design stage.

APPENDICES

Appendix 3-A

Flooding Records in 2010, Bien Hoa City

Appendix 3-A(1) Flooding Records in 2010, Bien Hoa City

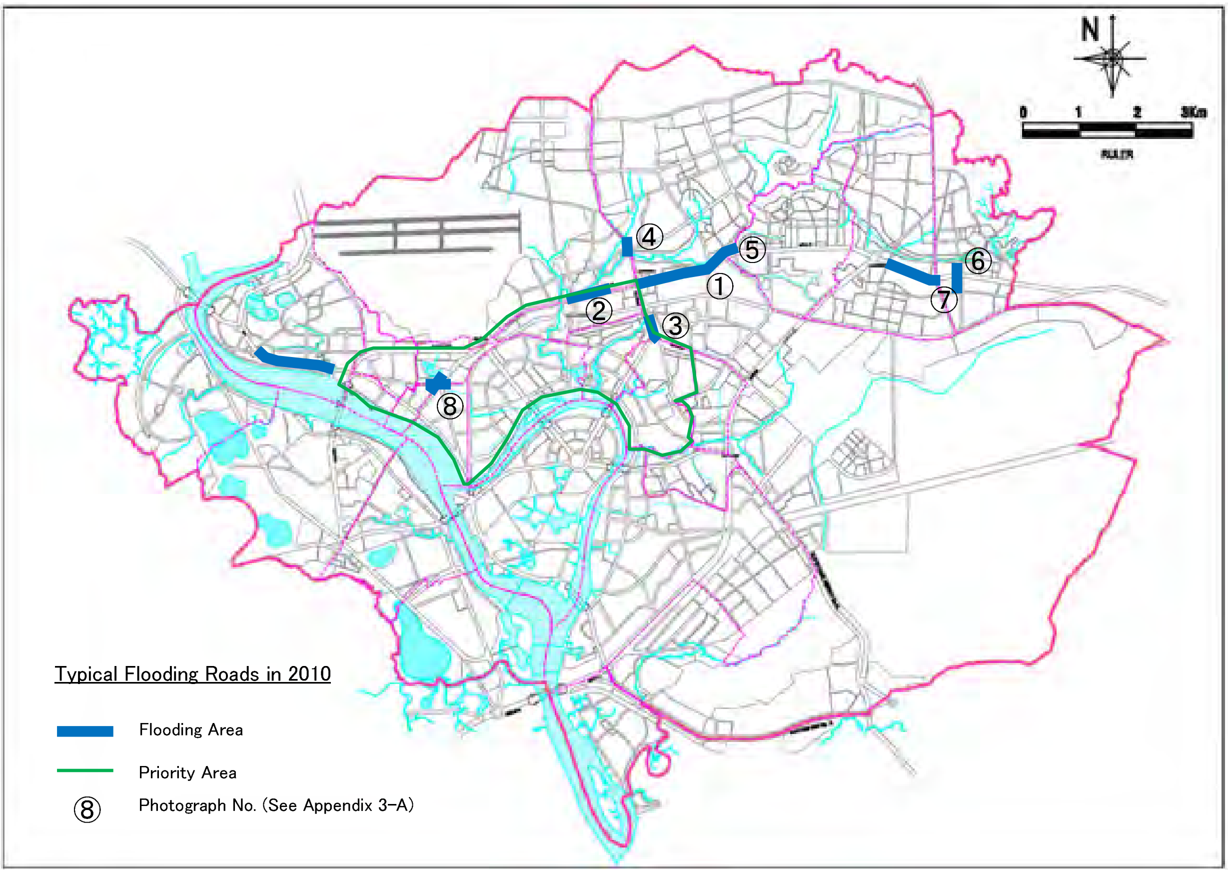
DATE	Flooding Location	Rainfall (mm)	
	Area	Rain Measuring Station at Quarter 3, Tan Hiep Ward	Rain Measuring Station at Quarter 3, Quyet Thang Ward
21/6/2010	Hung Dao Vuong street, section from Tinh Do pagoda to Bien Hung roundabout, Trung Dung Ward	-	53
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
22/6/2010	Nguyen Ai Quoc street, section from Dong Nai Supermarket to San Mau bridge, Tan Hiep Ward	52	0.2
	Dong khoi street, section from Dong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	Residential area located behind the Central Mental Hospital, Tan Phong Ward		
	30/4 Park area, Ho Nai Ward		
1/7/2010	Hung Đao Vuong street, section from Tinh Đo Pagoda to Bien Hung roundabout, Trung Dung Ward	112.8	194.5
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Nguyen Ai Quoc street, section from Đong Nai Supermarket to San Mau bridge, Tan Hiep Ward		
	Dong khoi street, section from Dong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	Residential area located behind the Central Mental Hospital, Tan Phong Ward		
	30/4 Park area, Ho Nai Ward		
	Tam Hoa Ward Market area		
	Area close to Trang Dai disposal site in Quarter 2, Trang Dai Ward		
	Vung Tau T-junction area, An Bình Ward		
	Quarter 6 area, Thong Nhat Ward		
	Quarter 11 area, Tan Hoa Ward		
	Lang Xeng sewer area, Thien Tan Water Supply Plant T-junction area,Tan Bien Ward		
	Flooding area at Quarters 4,5, Trang Dai Ward		
	Quarters 5,6,7,8 area, Tan Phong Ward		
	Dong Khoi street area, section from the crossroads at Amata IZ to Lu đoan 25 Cong binh gas station and the area in front of Tan Hiep Ward Police station		
	Residential areas along Săn Máu stream, Diên Hong stream, Rach Lung stream, branch of Linh stream, Tam Hoa Ward		

DATE	Flooding Location	Rainfall (mm)	
	Area	Rain Measuring Station at Quarter 3, Tan Hiep Ward	Rain Measuring Station at Quarter 3, Quyet Thang Ward
14/7/2010	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital	96.6	6.5
	Nguyen Ai Quoc street, section from Đong Nai Supermarket to San Mau bridge, Tan Hiep Ward		
	Dong khoi street, section from Dong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	Residential area located behind the Central Mental Hospital, Tan Phong Ward		
	30/4 Park area, Ho Nai Ward		
	Area close to Trang Dai disposal site in Quarter 2, Trang Dai Ward		
	Residential areas along San Mau stream, Diên Hong stream, Rach Lung stream, branch of Linh stream, Tam Hoa Ward		
	Quarter 11 area, Tan Hoa Ward		
	Lang Xeng sewer area, Thien Tan Water Supply Plant T-junction area,Tan Bien Ward		
	Flooding area at Quarters 4,5, Trang Dai Ward		
1/8/2010	Hung Dao Vuong street, section from Tinh Do Pagoda to Bien Hung roundabout, Trung Dung Ward	43.8	43.1
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Biên Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Nguyen Ai Quoc street, section from Dong Nai Supermarket to San Mau bridge, Tan Hiep Ward		
	Dong khoi street, section from Dong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	30/4 Park area, Ho Nai Ward		
	Tam Hoa Ward Market area		
	Area close to Trang Dai disposal site in Quarter 2, Trang Dai Ward		
	Vung Tau T-junction area, An Bình Ward		
	Quarter 11 area, Tan Hoa Ward		
	Lang Xeng sewer area, Thien Tan Water Supply Plant T-junction area,Tan Bien Ward		
	Quarters 5,6,7,8 area, Tan Phong Ward		
14/8/2010	Hung Dao Vuong street, section from Tinh Do Pagoda to Bien Hung roundabout, Trung Dung Ward	15	42
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Quarters 5,6,7,8 area, Tan Phong Ward		

DATE	Flooding Location	Rainfall (mm)	
	Area	Rain Measuring Station at Quarter 3, Tan Hiep Ward	Rain Measuring Station at Quarter 3, Quyet Thang Ward
21/8/2010	Hung Dao Vuong street, section from Tinh Do Pagoda to Bien Hung roundabout, Trung Dung Ward	40.1	51.8
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Nguyen Ai Quoc street, section from Dong Nai Supermarket to San Mau bridge, Tan Hiep Ward		
	Dong khoi street, section from Dong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	30/4 Park area, Ho Nai Ward		
	Tam Hoa Ward Market area		
	Area close to Trang Dai disposal site in Quarter 2, Trang Dai Ward		
	Vung Tau T-junction area, An Binh Ward		
	Quarter 11 area, Tan Hoa Ward		
	Lang Xeng sewer area, Thien Tan Water Supply Plant T-junction area,Tan Bien Ward		
	Quarters 5,6,7,8 area, Tan Phong Ward		
12/9/2010	Hưng Dao Vuong street, section from Tinh Do Pagoda to Bien Hung roundabout, Trung Dung Ward	22.3	57.2
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Tam Hoa Ward Market area		
	Quarters 5,6,7,8 area, Tan Phong Ward		
16/9/2010	Hung Dao Vương street, section from Tinh Đo Pagoda to Bien Hung roundabout, Trung Dung Ward	58.3	52.5
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Nguyen Ai Quoc street, section from Đong Nai Supermarket to San Mau bridge, Tan Hiep Ward		
	Dong khoi street, section from Dong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	30/4 Park area, Ho Nai Ward		
	Tam Hoa Ward Market area		
	Area close to Trang Dai disposal site in Quarter 2, Trang Dai Ward		
	Vung Tau T-junction area, An Binh Ward		
	Quarter 11 area, Tan Hoa Ward		
	Lang Xeng sewer area, Thien Tan Water Supply Plant T-junction area,Tan Bien Ward		
	Quarters 5,6,7,8 area, Tan Phong Ward		

DATE	Flooding Location	Rainfall (mm)	
	Area	Rain Measuring Station at Quarter 3, Tan Hiep Ward	Rain Measuring Station at Quarter 3, Quyet Thang Ward
4/10/2010	Hung Đao Vuong street, section from Tinh Đo Pagoda to Bien Hung roundabout, Trung Dung Ward	62.8	80.5
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Nguyen Ai Quoc street, section from Đong Nai Supermarket to San Mau bridge, Tan Hiep Ward		
	Đong khoi street, section from Đong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	30/4 Park area, Ho Nai Ward		
	Tam Hoa Ward Market area		
	Area close to Trang Dai disposal site in Quarter 2, Trang Dai Ward		
	Vung Tau T-junction area, An Binh Ward		
	Quarter 11 area, Tan Hòa Ward		
	Lang Xeng sewer area, Thien Tan Water Supply Plant T-junction area,Tan Bien Ward		
	Quarters 5,6,7,8 area, Tan Phong Ward		
8/10/2010	Hung Dao Vuong street, section from Tinh Do Pagoda to Bien Hung roundabout, Trung Dung Ward	18.9	65
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Tam Hoa Ward Market area		
	Quarters 5,6,7,8 area, Tan Phong Ward		
14/10/2010	Hung Dao Vuong street, section from Tinh Do Pagoda to Bien Hung roundabout, Trung Dung Ward	50.5	47
	Bien Hung Park area, Trung Dung Ward		
	Nguyen Ai Quoc street (in front of Bien Hoa Mental Hospital), section from Tan Hiep bridge to Mental Hospital		
	Huynh Van Nghe street, section from Buu Long Ward PC to Rach Lung bridge, Buu Long Ward		
	Nguyen Ai Quoc street, section from Dong Nai Supermarket to San Mau bridge, Tan Hiep Ward		
	Dong khoi street, section from Dong Khoi bridge to Tang Thiet Giap T-junction, Trang Dai Ward		
	Dong khoi street, section from Hoa Sen Nursery School to the gate of the office of Tan Hiep Ward Police		
	Ha Noi Highway, section from Chan Ly Church to Thong Nhat Hospital, Tan Bien Ward		
	30/4 Park area, Ho Nai Ward		
	Tam Hoa Ward Market area		
	Area close to Trang Dai disposal site in Quarter 2, Trang Dai Ward		
	Vung Tau T-junction area, An Binh Ward		
	Quarter 11 area, Tan Hoa Ward		
	Lang Xeng sewer area, Thien Tan Water Supply Plant T-junction area,Tan Bien Ward		
	Quarters 5,6,7,8 area, Tan Phong Ward		

Appendix 3-A(2) Flooding Locations and Photographs




1. Nguyen Ai Quoc Street- Tan Hiep Ward


1. Nguyen Ai Quoc Street- Tan Hiep Ward


1 Nguyen Ai Quoc Street


1. Nguyen Ai Quoc Street

(Tan Hiep Ward)	(Tan Hiep Ward)
 11 Nguyen Ai Quoc Street (Tan Hiep Ward)	 1. 1 Nguyen Ai Quoc Street (Tan Hiep Ward)
 2. Nguyen Ai Quoc Street, Tan Phong Ward, opposite to Mental Hospital	 2. Nguyen Ai Quoc Street, Tan Phong Ward, opposite to Mental Hospital
 3. Dong Khoi Street, Tan Hiep Ward	 3. Dong khoi Street, Tan Hiep Ward
 3. Dong Khoi Street- Tan Hiep Ward	 4. Quarter 7, Tan Phong Ward

(in front of DONRE)	
 4. Quarter 6, Tan Phong Ward	 4. Quarter 6, Tan Phong Ward
 5. Nguyen Ai Quoc Street, close to San Mau Bridge, Ho Nai Ward	 5. Nguyen Ai Quoc Street, close to San Mau Bridge, Ho Nai Ward
 6. Tan Bien Ward area (upstream of San Mau Stream)	 6. Tan Bien Ward area (upstream of San Mau Stream)
 7. Tan Bien Ward area	 7. Tan Bien Ward area

 8. Thanh Binh Ward area	 8. Thanh Binh Ward area
 8. Thanh Binh Ward area	 8. Thanh Binh Ward area

Appendix 3-B

Industrial Wastewater

Appendix 3- B Industrial Wastewater

1. Discharge Standard

Discharge standards of industrial wastewater are regulated in TCVN 5945:2005.

Column A category is applied as standards in the case of that industrial wastewater is discharged into the water bodies using for sources of domestic water supply. Colum B category is applied in the case of that wastewater is discharged only into other water bodies except for the water bodies using for sources of domestic water supply. When authority agencies permit to discharge wastewater into specific water bodies such as sewer connecting to the central sewage treatment plant (STP), separate wastewater reservoir, etc., column C category is applied.

In Bien Hoa, the Column A is applied for all industrial wastewater at present because wastewater is discharged into water bodies using for domestic water supply.

Table 3-B-1 TCVN 5945:2005 on Industrial Wastewater Discharge Standards

No	Parameters and substances	Unit	Limitation values		
			A	B	C
1	Temperature	Celsius	40	40	45
2	pH value	-	6 – 9	5.5 – 9	5 – 9
3	Odor	-	Unobjectionable	Unobjectionable	
4	Color at pH=7	Co-Pt	20	50	-
5	BOD_5 at 20 Celsius	mg/l	30	50	100
6	COD_{Cr}	mg/l	50	80	400
7	Suspended solids	mg/l	50	100	200
8	Arsenic	mg/l	0.05	0.1	0.5
9	Mercury	mg/l	0.005	0.01	0.01
10	Lead	mg/l	0.1	0.5	1
11	Cadmium	mg/l	0.005	0.01	0.5
12	Chromium (VI)	mg/l	0.05	0.1	0.5
13	Chromium (III)	mg/l	0.2	1	2
14	Copper	mg/l	2	2	5
15	Zinc	mg/l	3	3	5
16	Nickel	mg/l	0.2	0.5	2
17	Manganese	mg/l	0.5	1	5
18	Iron	mg/l	1	5	10
19	Tin	mg/l	0.2	1	5
20	Cyanide	mg/l	0.07	0.1	0.2
21	Phenol	mg/l	0.1	0.5	1
22	Mineral oil and fat	mg/l	5	5	10
23	Animal-vegetable fat and oil	mg/l	10	20	30
24	Chlorine residual	mg/l	1	2	-
25	PCBs	mg/l	0.003	0.01	-
26	Pesticide: organic phosphorous	mg/l	0.3	1	
27	Pesticide: organic chlorine	mg/l	0.1	0.1	-
28	Sulfide	mg/l	0.2	0.5	1
29	Fluoride	mg/l	5	10	15
30	Chloride	mg/l	500	600	1000

31	Ammonia (as N)	mg/l	5	10	15
32	Total nitrogen	mg/l	15	30	60
33	Total phosphorous	mg/l	4	6	8
34	Coliform	MPN/100ml	3000	5000	-
35	Bioassay		90% of the test fish exposed to the concentration of 100% wastewater survive after 96 hours of constant exposure		-
36	Gross α activity	Bq/l	0.1	0.1	-
37	Gross β activity	Bq/l	1.0	1.0	-

Source: TCVN 5945:2005

2. Environmental Protection Authority

On environmental protection authority, the Law on Environmental Protection, No 52/2005/QH11 regulates that Ministry of Natural Resources and Environment (MONRE) is the implantation authority for river basin (Article 62). At provincial level, Department of Natural Resources and Environment (DONRE) under MONRE implements environmental protection activities.

3. DONRE

3-1 Roles

According to Decision No.2/2009/QD-UBND of Dong Nai Provincial People's Committee mentions the roles of DONRE of Dong Nai Province on environment are presented in Table 3-B-2.

Table 3-B-2 Roles of DONRE regarding to Environment (Article 7) in Decision No.2/2009/QD-UBND

Roles on Environment
1. Assess conditions of the local environment regularly; investigate and recognize polluted areas, list the companies causing severe pollution for the local and report to the PPC and MONRE regularly based on the regulations; check these companies' solutions to the pollution; 2. Take responsibility or cooperate with relating agencies to built up and implement the resource mobilizing plan in order to cope with the environment pollution and solve that problem following the classification of the PPC; 3. Implement the certifying, prolonging, and recovering the license of people who collect, transport and treat dangerous solid waste upon the laws; guide, check and certify that they are allowed to receive the waste; 4. Consider the strategic environment assessment report, environment impact assessment report, environment protect scheme for external industrial zone, projects for natural protection areas, bio-diversity through the approval of the PPC; instruct and check the implementation after approving; 5. Take main responsibility and cooperate to organize the program on protecting, handling and improving the environment, protect and sustainably develop wetlands following the order of the PPC; 6. Set up and control the environment observing system following the laws; list and keep the environment data in local; 7. Carry out environmental protection activities under the management of Department; 8. Collect the fee for checking the Impact environment assessment report, environment protection fee regarding the laws; 9. Summarise the total estimated cost for environment protection activities of companies and units in local and cooperate with the MOF to report to the PPC and submit to the People's Council; take responsibility and cooperate with DOF to the provincial environmental protection fund.

Source: Decision No.2/2009/QD-UBND

3-2 Monitoring

DONRE makes the list of companies causing pollution and monitors the wastewater quality of these companies. This list is prepared for collecting environmental protection charges for wastewater based on Decree No.67/2003/ND-CP. These companies listed report wastewater quality and discharged volume every quarter to DONRE.

DONRE checks and monitors the wastewater quality by comparing these reports with discharge standards. In addition of these report reviews, DONRE conducts the supervision and inspection based on Article126 of Law on Environmental Protection for companies up to twice a year.

3-3 Sanctions against Environmental Protection

On sanctioning of administrative violation in the domain of environmental protection, Decree No.117/2009/ND-CP regulates sanctions including caution, fine, deprivation of licenses or certificates and remedy. The detail sanctions of this decree are presented I Table 3-B-3.

Table 3-B-3 Sanctions in Article 10 Violation of Regulations on Wastewater Discharge of Decree No.117/2009/ND-CP

Clause	Article 10. Violation of regulations on wastewater discharge
1.	Acts of discharging wastewater less than two times in excess of standards or technical regulations on wastewater shall be sanctioned as follows: a/ Caution shall be served or a fine of between VND 100,000 and 500,000 shall be imposed for discharging a wastewater amount of less than 10 m^3/day (24 hours); b/ A fine of between VND 500,000 and 2,000,000 shall be imposed for discharging a wastewater amount of between 10 m^3/day (24 hours) and less than 50 m^3/day (24 hours); c/ A fine of between VND 2,000,000 and 10,000,000 shall be imposed for discharging a wastewater amount of between 50 m^3/day (24 hours) and less than 500 m^3/day (24 hours); d/ A fine of between VND 10,000,000 and 20,000,000 shall be imposed for discharging a wastewater amount of between 500 m^3/day (24 hours) and less than 2,000 m^3/day (24 hours); e/ A fine of between VND 20,000,000 and 50,000,000 shall be imposed for discharging a wastewater amount of between 2,000 m^3/day (24 hours) and less than 5,000 m^3/day (24 hours); f/ A fine of between VND 50,000,000 and 100,000,000 shall be imposed for discharging a wastewater amount of between 5,000 m^3/day (24 hours) and less than 10,000 m^3/day (24 hours); g/ A fine of between VND 100,000,000 and 150,000,000 shall be imposed for discharging a wastewater amount of 10,000 m^3/day (24 hours) or more.
2.	Acts of discharging wastewater between two times and less than five times in excess of standards or technical regulations on wastewater shall be sanctioned as follows: a/ A fine of between VND 500,000 and 2,000,000 shall be imposed for discharging a wastewater amount of less than 10 m^3/day (24 hours); b/ A fine of between VND 2,000,000 and 8,000,000 shall be imposed for discharging a wastewater amount of between 10 m^3/day (24 hours) and less than 50 m^3/day (24 hours); c/ A fine of between VND 8,000,000 and 20,000,000 shall be imposed for discharging a wastewater amount of between 50 m^3/day (24 hours) and less than 500 m^3/day (24 hours); d/ A fine of between VND 20,000,000 and 50,000,000 shall be imposed for discharging a wastewater amount of between 500 m^3/day (24 hours) and less than 2,000 m^3/day (24 hours): e/ A fine of between VND 50,000,000 and 100,000,000 shall be imposed for discharging a wastewater amount of between 2,000 m^3/day (24 hours) and less than 5,000 m^3/day (24 hours);

	f/ A fine of between VND 100,000,000 and 150,000,000 shall be imposed for discharging a wastewater amount of between 5,000 m^3/day (24 hours) and less than 10,000 m^3/day (24 hours); g/ A fine of between VND 150,000,000 and 200,000,000 shall be imposed for discharging a wastewater amount of 10,000 m^3/day (24 hours) or more.
3.	Acts of discharging wastewater between five times and less than 10 times in excess of standards or technical regulations on wastewater shall be sanctioned as follows: a/ A fine of between VND 2,000,000 and 8,000,000 shall be imposed for discharging a wastewater amount of less than 10 m^3/day (24 hours); b/ A fine of between VND 8,000,000 and 20,000,000 shall be imposed for discharging a wastewater amount of between 10 m^3/day (24 hours) and less than 50 m^3/day (24 hours); c/ A fine of between VND 20,000,000 and 50,000,000 shall be imposed for discharging a wastewater amount of between 50 m^3/day (24 hours) and less than 500 m^3/day (24 hours); d/ A fine of between VND 50,000,000 and 100,000,000 shall be imposed for discharging a wastewater amount of between 500 m^3/day (24 hours) and less than 2,000 m^3/day (24 hours); e/A fine of between VND 100,000,000 and 150,000,000 shall be imposed for discharging a wastewater amount of between 2,000 m^3/day (24 hours) and less than 5,000 m^3/day (24 hours); f/ A fine of between VND 150,000,000 and 200,000,000 shall be imposed for discharging a wastewater amount of between 5,000 m^3/day (24 hours) and less than 10,000 m^3/day (24 hours): g/ A fine of between VND 200,000,000 and 250,000,000 shall be imposed for discharging a wastewater amount of 10,000 m^3/day (24 hours) or more.
4.	Acts of discharging wastewater 10 times or more in excess of standards or technical regulations on wastewater shall be sanctioned as follows: a/ A fine of between VND 8,000,000 and 20,000,000 shall be imposed for discharging a wastewater amount of under 10 m^3/day (24 hours); b/ A fine of between VND 20,000,000 and 50,000,000 shall be imposed for discharging a wastewater amount of between 10 m^3/day (24 hours) and less than 50 m^3/day (24 hours); c/ A fine of between VND 50,000,000 and 100,000,000 shall be imposed for discharging a wastewater amount of between 50 m^3/day (24 hours) and less than 500 m^3/day (24 hours); d/ A fine of between VND 100,000,000 and 150,000,000 shall be imposed for discharging a wastewater amount of between 500 m^3/day (24 hours) and less than 2,000 m^3/day (24 hours); e/ A fine of between VND 150,000,000 and 200,000,000 shall be imposed for discharging a wastewater amount of between 2,000 m^3/day (24 hours) and less than 5,000 m^3/day (24 hours); f/ A fine of between VND 200,000,000 and 250,000,000 shall be imposed for discharging a wastewater amount of between 5,000 m^3/day (24 hours) and less than 10,000 m^3/day (24 hours); g/ A fine of between VND 250,000,000 and 300,000,000 shall be imposed for discharging a wastewater amount of 10,000 m^3/day (24 hours) or more.
5.	Acts of discharging wastewater which contain hazardous substances in excess of standards or technical regulations on wastes shall be sanctioned as follows: a/ An increase of between 20% and 30% of the corresponding fine, for violations specified at Points a, b. c and d, Clause 1; Points a, b and c, Clause 2; Points a and b. Clause 3; and Point a, Clause 4, of this Article, if wastewater contains hazardous substances; b/ An increase of between 30% and 40% of the corresponding fine, for violations specified at Points e and f, Clause 1; Points d and e, Clause 2; Points c and d, Clause 3; and Points b and c, Clause 4, of this Article, if wastewater contains hazardous substances; c/ An increase of between 40% and 50% of the corresponding fine, for violations specified at Point g, Clause 1; Points f and g, Clause 2; Points e, f and g, Clause 3; and Points d, e, f and g, Clause 4, of this Article, if wastewater contains hazardous substances.
6.	A fine of between VND 400,000,000 and 500,000,000 shall be imposed for discharging wastewater which contains radioactive substances causing environmental radioactive contamination in excess of prescribed standards or technical regulations.

7.	Additional sanction: Deprivation of the right to use practice licenses or certificates until complete application of environmental protection measures, for violations specified at Point g, Clause 3; Points f and g, Clauses 4 and 5; and Clause 6, of this Article.
8.	Remedy: Within the time limit set by persons with sanctioning competence in administrative sanctioning decisions, forced application of measures to remedy environmental pollution caused by violations specified in this Article.

Source: Decree No.117/2009/ND-CP

4. Factories located out of Industrial Parks

Main factories in the area of priority project1 are presented in Table 3-B-4. Types of business are not identified. Big factories are planned to be moved to industrial parks in the Adjusted General Plan of Bien Hoa.

Table 3-B-4 Factories located out of Industrial Parks

Name of Factory	Water Consumption (m^3/d)
VMEP Company	378
Binh Tien Dong Nai Company	267
Corporation No.28	228
Dong Tien JSC.	180
A42 Factory	104
Agricultural Produce and Food Processing Import Export Company	100
Le Phan Ha Concrete Factory	58
FASHY Company	53
BERYAYA_D2D Co; Ltd.	48
Tan Phu Hoa	42
Tin Nghia One member Co., Ltd.	40
Dong Thinh Clothing Company	36

Source: JICA Preparatory Study Phase I

5. Wastewater Treatment Methods used in Industrial parks

Wastewater Treatment methods used in industrial parks of Bieh Hoa are presented in Table 3-B-5. There are not industrial parks in the area of priority project I.

Table 3-B-5 Wastewater Treatment Methods used in Industrial Parks

Industrial Park	Wastewater Treatment Method
Amata	Conventional Activated Sludge
Bien Hoa I	Wastewater is sent and treated at Bien Hoa II
Bien Hoa II	Sequencing Batch Reactor
Loteco	N/A

Source: PMU

Appendix 4-A

Consideration of Intercepting Ratio of Combined Sewer System

Appendix 4-A Consideration of Intercepting Ratio of Combined Sewer System

Sewer size of combined system is calculated by storm water flow rate and sewage flow rate. Storm water flow rate is calculated according to the design criteria as described Chapter 6. Sewage flow rate is calculated according to the unit sewage flow and peaking factor as shown Table 5.2.3 and Table 4.6.7, respectively. The design criteria of drainage system and the unit flow are shown as follow.

< The design criteria of drainage system>

Rainfall intensity (q) is

$$q = \frac{A(1 + c \lg P)}{(t+b)^n}$$

In which; A: 11,650

c: 0.58

P: Return period of rainfall (= 2 years in combined system area)

t: Concentration time (min)

b: 32

n: 0.95

<Unit sewage flow>

Unit sewage flow(qs) of combined system: 0.001829 l/capita/sec (Refer to Table 5.2.3)

(qs = 0.001829 l/capita/sec × 63,269 peoples ÷ 272 ha

= 0.4255 l/sec.ha)

Intensity of storm water runoff and sewage flow are calculated in order to compare the intercepting ratio as following Table 4.6.8. Hyetographs of total flow and sewage flow are shown in Figure 4.6.1.

Intercepting Ratio	Intercepting Flow Ratio (%)	Discharge Flow Ratio (%)
1qs	4.2	95.8
2qs	8.5	91.5
3qs	12.6	87.4

In this study, the intercepting ratio is more than 2, therefore the intercepting flow ratio is more than 8.5% during rain period.

Table 4.6.8 Intensity of Total Flow and Sewage Flow

Time	Intensity(mm/hr)					
	Rainfall	Runoff	Total Flow	Intercepting Ratio		
				1qs	2qs	3qs
0:00	0.339	0.251	0.403	0.152	0.304	0.403
1:00	0.384	0.284	0.436	0.152	0.304	0.436
2:00	0.420	0.311	0.463	0.152	0.304	0.456
3:00	0.494	0.366	0.518	0.152	0.304	0.456
4:00	0.564	0.417	0.569	0.152	0.304	0.456
5:00	0.673	0.498	0.650	0.152	0.304	0.456
6:00	0.831	0.615	0.767	0.152	0.304	0.456
7:00	1.061	0.785	0.937	0.152	0.304	0.456
8:00	1.449	1.072	1.224	0.152	0.304	0.456
9:00	2.199	1.627	1.779	0.152	0.304	0.456
10:00	4.027	2.980	3.132	0.152	0.304	0.456
11:00	11.996	8.877	9.029	0.152	0.304	0.456
12:00	67.130	49.676	49.828	0.152	0.304	0.456
13:00	11.996	8.877	9.029	0.152	0.304	0.456
14:00	4.027	2.980	3.132	0.152	0.304	0.456
15:00	2.199	1.627	1.779	0.152	0.304	0.456
16:00	1.449	1.072	1.224	0.152	0.304	0.456
17:00	1.061	0.785	0.937	0.152	0.304	0.456
18:00	0.831	0.615	0.767	0.152	0.304	0.456
19:00	0.673	0.498	0.650	0.152	0.304	0.456
20:00	0.564	0.417	0.569	0.152	0.304	0.456
21:00	0.494	0.366	0.518	0.152	0.304	0.456
22:00	0.420	0.311	0.463	0.152	0.304	0.456
23:00	0.384	0.284	0.436	0.152	0.304	0.436
0:00	0.339	0.251	0.403	0.152	0.304	0.403
Total(mm/day)		85.840	89.640	3.800	7.600	11.253
Intercepting Ratio(%)		-	-	4.2%	8.5%	12.6%
Discharge Ratio(%)		-	-	95.8%	91.5%	87.4%

Note: Runoff Intensity = Rainfall Intensity × Runoff Coeficient(0.74)

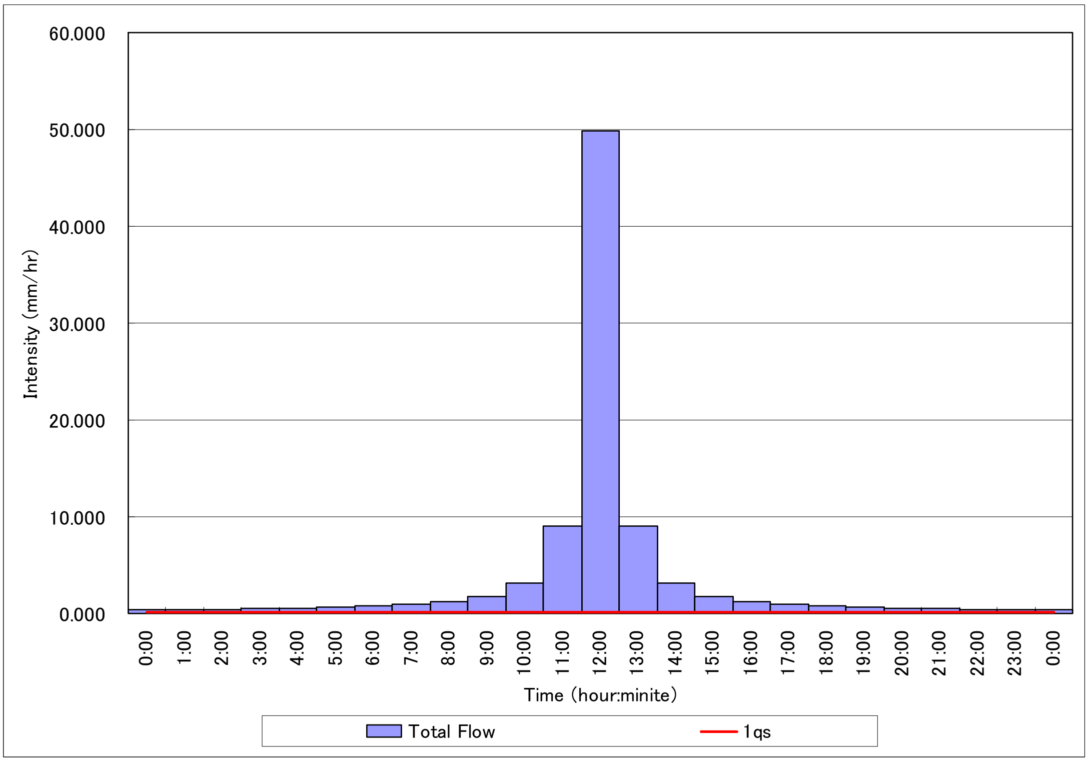


Figure 4.6.1 Hyetographs of Total Flow and sewage flow

Appendix 4-B

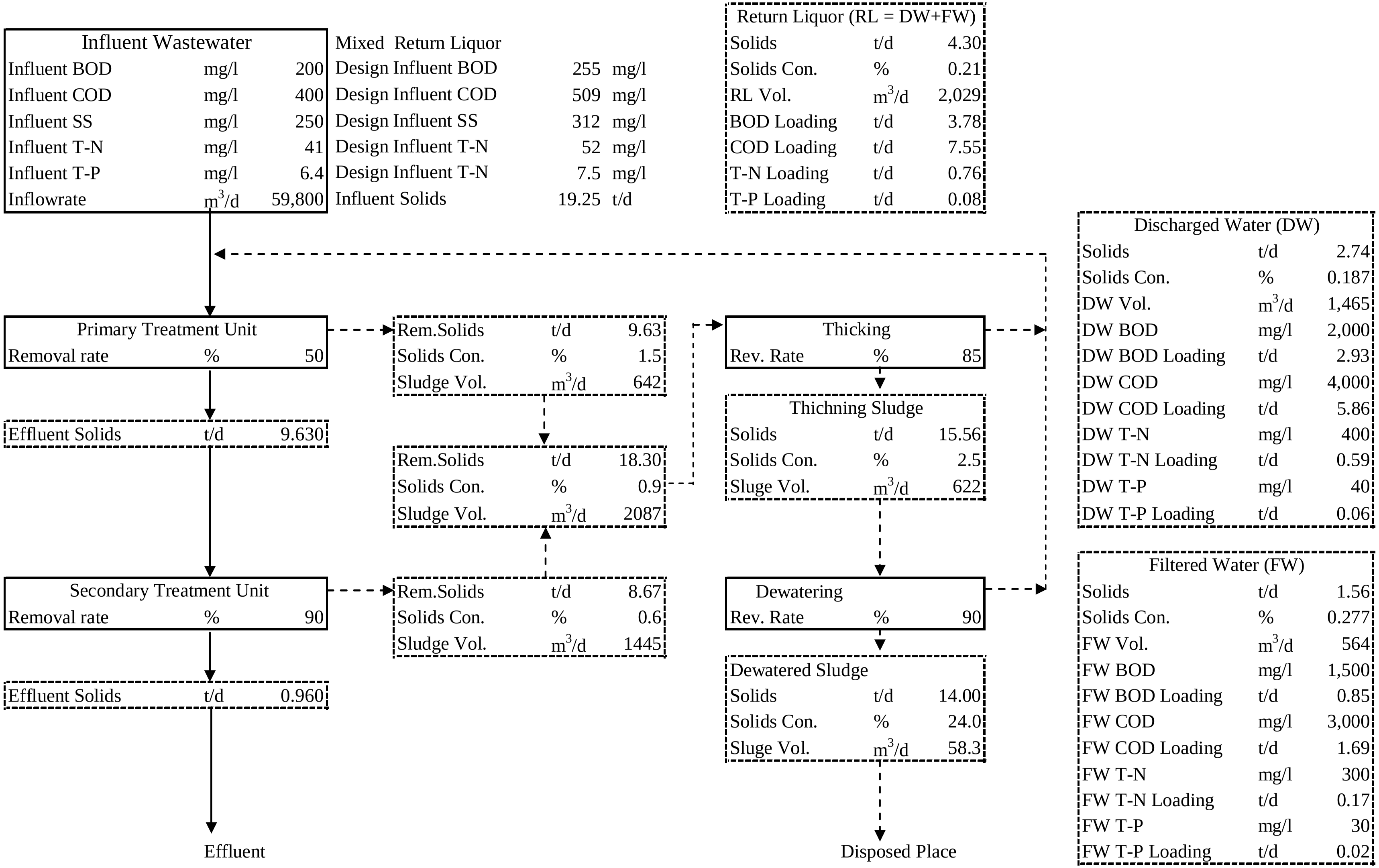
Capacity Calculation for STP2

Appendix 4-B1: Capacity Calculation of Conventional Activated Sludge Process

Item	Calculation					
1. Design Parameters						
1-1 Outline of Wastewater Treatment						
(1) Area of Plant	9.34 ha					
(2) Grand Level of Plant	3.61 M					
(3) Type of Collection System	Separate Sewer System					
(4) Water Treatment Process	Conventional Activated Sludge Process					
1-2 Design Flowrate Waste Water						
(1) Average Daily Flowrate	52,000 m^3/d					
(2) Maximum Daily Flowrate	59,800 m^3/d					
(3) Maximum Hourly Flowrate	72,800 m^3/d					
1-3 Influent Wastewater Quality Waste Water						
(1) BOD	200 mg/l					
(2) COD_{Cr}	400 mg/l					
(3) SS	250 mg/l					
(4) T-N	41 mg/l					
(5) T-P	6.4 mg/l					
1-4 Design Influent Wastewater						
(1) BOD	255 mg/l	→	260 mg/l			
(2) COD_{Cr}	509 mg/l	→	510 mg/l			
(3) SS	312 mg/l	→	320 mg/l			
(4) T-N	52 mg/l	→	60 mg/l			
(5) T-P	7.5 mg/l	→	8 mg/l			
1-5 Removal Efficiency (Total System)	Primary Treatment (PRE)		Secondary Treatment (SRE)	Total Treatment (TRE)		
(1) BOD	50 %		90 %	95.0 %		
(2) COD_{Cr}	40 %		70 %	82.0 %		
(3) SS	50 %		90 %	95.0 %		
(4) T-N	10 %		60 %	64.0 %		
(5) T-P	20 %		40 %	52.0 %		
1-6 Effluent Wastewater Quality						
(1) BOD	13.0 mg/l	＜	30 mg/l	(Effluent Discharge Criteria)		
(2) COD_{Cr}	91.8 mg/l	＜	- mg/l	(Effluent Discharge Criteria)		
(3) SS	16.0 mg/l	＜	50 mg/l	(Effluent Discharge Criteria)		
(4) T-N	21.6 mg/l	＜	30 mg/l	(Effluent Discharge Criteria)		
(5) T-P	3.9 mg/l	＜	6.0 mg/l	(Effluent Discharge Criteria)		

Item	Calculation
Sludge Production (Maximum Daily Flowrate)	
1-7 Return Liquor (with Influent Wastewater)	Quantity = 2,029 m^3/day Quantity (DM)= 61,830 m^3/day
1-8 Raw Sludge	Solids＝ DM×Influent SS×PRE（SS）×10^{-6} Solids＝ 61,830 m^3/d× 320 mg/l× 50 %× 10^{-6} ＝ 9.89 ds-t/d Solid Concentration ＝ 1.5 % Sludge ＝ Solids÷Solids Concentration×10^2 Sludge ＝ 9.89 t/d ÷ 1.5 % × 10^2 Sludge(OUT) ＝ 660 m^3/d
1-9 Waste Activated Sludge	Influent Reactor Solids＝ DM×Influent SS×10^{-6}−Raw Sludge ＝ 9.90 ds-t/d Solids＝ Influent Reactor Solids×SRE(SS） Solids＝ 9.90 ds-t/d × 90 % ＝ 8.91 ds-t/d Solid Concentration ＝ 0.6 % Sludge ＝ Solids÷Solids Concentration×10^2 Sludge ＝ 8.91 t/d ÷ 0.6 % × 10^2 Sludge(OUT) ＝ 1,485 m^3/d
1-10 Thickening	Solids (IN) ＝ 18.80 ds-t/d Solids(OUT) ＝ WAS×Recovery Rate×10^{-2} Solids (OUT) ＝ 18.80 t/d × 85 % × 10^-2 Ricovery Rate ＝ 85 % ＝ 15.98 ds-t/d Sludge(OUT) ＝ Solids÷Solids Concentration×10^2 Sludge(OUT) ＝ 15.98 t/d ÷ 3 % × 10^2 Solid Concentration ＝ 2.5 % Sludge(OUT) ＝ 640 m^3/d
1-11 Dewatering	Solids (IN) ＝ 15.98 ds-t/d Solids(OUT) ＝ WAS×Recovery Rate×10^{-2} Solids (OUT) ＝ 15.98 t/d × 90 % × 10^-2 Ricovery Rate ＝ 90 % ＝ 14.39 ds-t/d Sludge(OUT) ＝ Solids÷Solids Concentration×10^2 Sludge(OUT) ＝ 14.39 t/d ÷ 24 % × 10^2 Solid Concentration ＝ 24 % Sludge(OUT) ＝ 60.0 m^3/d

1-12 Solids Mass Balance



Item	Calculation
2. Primary Sedimentation Tank	
2-1 Basin Volume	
Design Flowrate	
Maximum Daily Flowrate	= 59,800 m^3/d
Maximum hourly Flowrate	= 72,800 m^3/d
Temperature for design	= 28 ℃ : Lowest water temperature in monthly average
Desgin overflow rate (For Maximum Daily Flowrate)	= 50 $m^3/m^2/d$
Required Area for settling	= 59,800 ÷ 50 = 1,196 m^2
No. of basin	= 16 basins
Required Area for one settling basin	= 1,196 ÷ 16 = 75 m^2
Width	= 4.0 m (Standard : 3.0 ～ 4.0, Maximum 5.0m)
Length	= 19.0 m ＞ 12.0 m (Width × 3)
Effective Area	= 4.0 m × 19.0 m × 16 = 1,216 m^2
Depth of basin	= 3.5 m (Standard : 2.5 ～ 4.0)
Overflow rate	
Maximum Daily Flowrate	= 59,800 m^3/d ÷ 1,216 m^2
	= 49.2 $m^3/m^2/d$
Settling Time	= (1,216 × 3.5 × 24) ÷ 59,800
	= 1.7 hrs
Weir Loading rate	= 250 $m^3/m/d$
	= 59,800 ÷ 250 ÷ 16 = 15.0 m/basin
Sludge Pump Capacity	= 660 m^3/d = 0.46 m^3/min
2-2 Effluent Wastewater Quality	

	Influent (mg/l)	Removal Efficiency (%)	Effluent (mg/l)
BOD	260	50	130
SS	320	50	160

Item	Calculation

3. Reactor

3-1 Reactor Volume

Design Flowrate

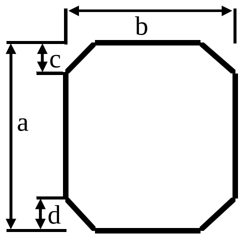
Maximum Daily Flowrate	＝	59,800	m^3/d
Maximum hourly Flowrate	＝	72,800	m^3/d
Hydraulic Detention Time (For Maximum Daily Flowrate)	＝	8.0	hours
MLSS	＝	2,000	mg/l（1,500～2,000mg/l）

Req. Volume ＝ 59,800 $m^3/d \times 8$ hrs ÷ 24
＝ 19,933 m^3

Number of Reactor ＝ 8 Reactors

One reactor Volume ＝ 19,933 ÷ 8 ＝ 2500 m^3

Water Depth	a	＝	5.5	m
Width	b	＝	8.5	m
Height in Upside Corner	c	＝	0.8	m
Height in Downside Corner	d	＝	1.0	m



Req. Total Length ＝ 2,500 m3 ÷（5.5 m × 8.5 m －0.8 × 0.8 m －1.0 × 1.0 m）
＝ 55.5 m → 58.0 m

3-2 Effluent Wastewater Quality

	Influent (mg/l)	Removal Efficiency (%)	Effluent (mg/l)	Discharge Criteria (mg/l)
BOD	130	90	13.0	30
SS	160	90	16.0	50

※: Soluble BOD = 65 mg/l (assumed to be half of Influent BOD)

3-3 Partition of Reactor

(1) Partition Proportion

	1st Cell	2nd Cell	3rd Cell	4th Cell
Case1	1.00	1.00	1.00	1.00
Case2	1.00	1.50	1.50	2.25

(2) Operating Condition

Condition1 : Conventional Operation
Condition2 : Bulking Measures Operation
Condition3 : Nitrification and Denitrification Operation

(3) Cell Conditions

	1st Cell	2nd Cell	3rd Cell	4th Cell
Condition1	Aerobic	Aerobic	Aerobic	Aerobic
Condition2	Anaerobic	Aerobic	Aerobic	Aerobic
Condition3	Anoxic	Aerobic	Anoxic	Aerobic

Item	Calculation

(4) Design Operating Pattern

Operating pattern is set for the partition and conditions as follows.

Pattern	Partition	Condition	Reactor 1	Reactor 2	Reactor 3	Reactor 4
			1	1	1	1
A-1	CaseA	Condition1	O	O	O	O
A-2	CaseA	Condition2	A	O	O	O
A-3	CaseA	Condition3	A	O	A	O
			1	1.5	1.5	2.25
B-1	CaseB	Condition1	O	O	O	O
B-2	CaseB	Condition2	A	O	O	O
B-3	CaseB	Condition3	A	O	A	O

(5) Activated Sludge Volume Ratio in Aerobic Conditions

	A-1	A-2	A-3	B-1	B-2	B-3
Step Feeding Ratio (r1)	1.0	1.0	0.5	1.0	1.0	0.5
Return Sludge Volume Ratio	0.5	0.5	0.5	0.5	0.5	0.5
MLSS (Return Sludge : mg/l)	6,000	6,000	6,000	6,000	6,000	6,000
MLSS (Reactor 1 and 2 : mg/l)	2,000	2,000	3,000	2,000	2,000	3,000
MLSS (Reactor 3 and 4 : mg/l)	2,000	2,000	2,000	2,000	2,000	2,000
Volume Ratio of Aerobic Tank※	1.000	0.750	0.500	1.000	0.840	0.600
Sludge Volume Ratio of Aerobic Tank	1.000	0.750	0.625	1.000	0.840	0.720

※ :Volume ratio and Sludge volume ratio are the ratio of A-1.

(6) ASRT

$$\theta c = \frac{\theta \cdot XA}{a \cdot Scs + b \cdot Sss - c \cdot \theta \cdot XA}$$

θ c ; ASRT（Aerobic Solids Retention Time : d)
XA ; MLSS in Reactor
Case 1 = 1,500 mg/l
Case 2 = 2,000 mg/l
Scs ; Influent soluble BOD = 65 mg/l
Sss ; Influent SS = 160 mg/l
a ; Rate of Sludge coversion from S-BOD
= 0.50 gMLSS/gS-BOD (0.4～0.6)
*S-BOD : Soluble BOD
b ; Rate of Sludge production from SS
= 0.95 gMLSS/gSS (0.9～1.0)
c ; Decay rate = 0.04 1/d (0.03～0.05)
θ ; Aeration time = HRT × Sludge Ratio※
= 0.333 d × Sludge Ratio※
※ : Sludge Ratio is Aerobic Sludge Volume Ratio.

Pattern	Sludge Ratio※	θ (day)	θ c ; ASRT (day)	
			Case1 (1,500)	Case2 (2,000)
A-1	1.000	0.333	3.04	4.22
A-2	0.750	0.250	2.22	3.04
A-3	0.625	0.208	1.82	2.48
B-1	1.000	0.333	3.04	4.22
B-2	0.840	0.280	2.51	3.46
B-3	0.720	0.240	2.12	2.91

Item	Calculation
(7) Estimate of BOD in the treated water	C-BOD in the treated water is estimated by the following formula. (In case of MLSS is 1,500mg/l)

	A	B
Under 15℃	13.73	θ c^(-0.554)
15～20℃	10.42	θ c^(-0.519)
20～25℃	9.75	θ c^(-0.671)
Over 25℃	11.54	θ c^(-0.744)

C-BOD ＝ 11.54 θ c＾(-0.744) : Carbonacious BOD

The C-BOD ratio of average value and 95% non-exceedance probability value in Wastewater treatment plant (that uses a conventional activated sludge process) is about 2.2 times in Japanese experience.

Pattern	ASRT θc (day)	C-BOD of treated water (mg/l)	95% non-exceedance probability value (×2.2 mg/l)	Discharge Criteria (mg/l)	Check
A-1	3.04	5.05	11.11	30	O.K.
A-2	2.22	6.38	14.04	30	O.K.
A-3	1.82	7.39	16.26	30	O.K.
B-1	3.04	5.05	11.11	30	O.K.
B-2	2.51	5.82	12.80	30	O.K.
B-3	2.12	6.60	14.52	30	O.K.

And the C-BOD ratio of average value and maximum value is about 3 times in Japanese experience.

Pattern	ASRT θc (day)	C-BOD (mg/l)	Maximum C-BOD value (× 3 mg/l)	Discharge Criteria (mg/l)	Check
A-1	3.04	5.05	15.15	30	O.K.
A-2	2.22	6.38	19.14	30	O.K.
A-3	1.82	7.39	22.17	30	O.K.
B-1	3.04	5.05	15.15	30	O.K.
B-2	2.51	5.82	17.46	30	O.K.
B-3	2.12	6.60	19.80	30	O.K.

(8) Nitrification reaction

The temperature for nitrification ratio is over 80% is required by the following formula.

$$T = -\frac{1}{0.0639} \ln \frac{\theta c}{20.65}$$

※ : θc ＝ 20.65 exp(-0.0639T)

Pattern	ASRT : θc(day)	Required Temp	Temp	Check
A-1	4.22	24.85	28	O.K.
A-2	3.04	29.98	28	N.G.
A-3	2.48	33.17	28	N.G.
B-1	4.22	24.85	28	O.K.
B-2	3.46	27.96	28	O.K.
B-3	2.91	30.67	28	N.G.

※:MLSS = 2,000mg/l

Item	Calculation
(9) Size of Reactor	
Process	Conventional Activated Sludge Process
Width	＝ 8.5 m
Length	＝ 58.0 m
Water Depth	＝ 5.5 m
Number of Reactor	＝ 8 Reactors
Volume	＝ 2,711 m^3/reactor > 2500 m^3 OK
3-2 Aerator	
(1) Design Parameters	
Maximum Daily Flowrate	＝ 59,800 m^3/d
Influent BOD	＝ 130 mg/l
Effluent BOD	＝ 13 mg/l
Influent S-BOD	＝ 65 mg/l
Influent SS	＝ 160 mg/l
Influent Kj-N	＝ 54 mg/l
MLSS	＝ 2,000 mg/l
HRT	＝ 8 hrs
(2) Organic Loading Rate	
Organic Loading Rate	$= \frac{X_I \times Q}{X_A \times V} = \frac{130 \times 7,475}{2,000 \times 2,711}$
	＝ 0.18 kg/BOD/d/kgMLSS
	V ; Reactor Volume, m^3
	Q ; Maximum Daily Flowrate/Reactor
	＝ 59,800 ÷ 8 ＝ 7,475 m3/d
	X_I ; Influent BOD ＝ 130 mg/l
	X_A ; MLSS
(3) Oxigen requirement for BOD oxidation OD1	＝ A × (Removed BOD − Denitrified N × K)
	A ; Reqired O_2/Removed BOD
	＝ 0.6 kg as O_2/kg as BOD
	K ; Consumed BOD by Denitrification
	＝ 2.0 kg as BOD/kg as N
	Removed BOD ＝ 0.117 × 59,800
	＝ 6,997 kg as BOD/d
	Denitrified N ; Assuming all nitrified N is denitrified.
	※ Oxigen requirement by denitrification is the margin.
OD1	＝ 0.6 × (6,997 − 0 × 2.0)
	＝ 4,198 kg as O_2/d

Item	Calculation
(4) Oxigen requirement for Internal respiration	
OD2	= B × Va × MLVSS
	B ; O_2 Volume for internal aspiration
	= 0.10 kg as O^2/kg as MLVSS/d
	Va ; Aerobic zone volume
	Assuming MLVSS/MLSS is 0.8
OD2	= 0.1 × 21,688 × 2.0 × 0.8
	= 3,470 kg as O_2/d
(5) Oxigen requirement for nitrification OD3	= C × Nitrified N
	C ; O_2 consumed by nitrification
	= 4.57 kg as O_2/kg as N
	Nitrified N ; Amount of nitrifired nitrogen
	; Influent N − Effluent no nitrified N
	− nitrogen of WAS
	Influent N ; 0.054 × 59,800
	= 3229.2 kg as N/d
	Effluent no-N ; Assuming all N is nitrified
	Nitrogen of WAS = 0.08 (kg as N/kg as MLSS)
	× Qw×Xx
	$Q_W \times X_X = Q_{in}(a \times C_{S-BOD,in} + b \times C_{ss,in} - c \times X_A \times \tau_A) \times 10^{-3}$
	a = 0.50 gMLSS/gS-BOD
	$C_{S\text{-}BOD}$ = 65 mg/l
	b = 0.95 gMLSS/gSS
	C = 0.04 1/d
	τ_A ; Aeration time = 0.333 d
	Qw×Xa = 59,800 × (0.5 × 65 +
	0.95 × 160 −
	0.04 × 2,000 × 0.333)× 10^{-3}
	= 9,438 kg/d
	Nitrogen of WAS = 0.08 × 9,438
	= 755.1 kg as N/d
OD3	= 4.57 ×(3229.2 − 0 − 755.1)
	= 11,307 kg as O_2/d
(6) Oxigen requirement inEffluent OD4	= Oxigen in effluent
	= 1.5 × 59,800 × 10^-3
	= 90 kg as O_2/d
(7) Actual Oxigen Requirement	
AOR	= OD_1 + OD_2 + OD_3 + OD_4
	= 4,198 + 3,470 + 11,307 + 90
	= 19,065 kg as O_2/d

Item	Calculation
(8) Standard Oxigen Requirement SOR	$= \dfrac{AOR \times C_{SW}}{1.024^{(t-20)} \times \alpha \times (\beta \times C_S - C_a)} \times \dfrac{760}{P}$
	C_{SW} ; Oxygen saturation concentration in clean water at 20 Celsius = 8.84 mg/l
	Ca ; Average DO = 1.5 mg/l
	Cs ; Oxygen saturation concentration in clean water at t Celsius = 8.39 mg/l; t = 28 Celsius
	α ; 0.93
	β ; 0.97
	P ; 720 (470meter above sea level)
SOR	= 23,836 kg as O_2/d
	= 23,836 ÷ 24 hr = 993.2 kg as O_2/hr
	= 993.2 ÷ 60 min = 16.6 kg as O_2/min
	Required Oxygen
	$= \dfrac{23,836}{0.13 \times 59,800} =$ 3.1 kg as O_2/kg as BOD
(9) Required Air Volume	$Gs = \dfrac{SOR}{Ep \times \rho \times Ow} \times 100 \times \dfrac{273+T_2}{273}$
	Gs ; Required Air Volume (m^3/d)
	E_A ; Oxygen Transfer Efficiency (15 %)
	ρ ; Air Density (1.293 kg/m^3N-Air)
	O_W ; Oxygen Content in Air (0.232 kg-O_2/m^3N-Air)
	$Gs = \dfrac{23,836}{15 \times 1.293 \times 0.232} \times 100 \times \dfrac{273 + 28}{273}$
	= 584,059 m^3/d
	= 406 m^3/min

Item	Calculation
4. Secondary Sedimentation Tank	
4-1 Basin Volume	
Design Flowrate	
Maximum Daily Flowrate	＝ 59,800 m^3/d
Maximum hourly Flowrate	＝ 72,800 m^3/d
Desgin overflow rate (For Maximum Daily Flowrate)	＝ 20 $m^3/m^2/d$
S	＝ $2.45 \times 10^6 \times T^{0.95} \times X_A^{-1.35} \times [SVI]^{-0.77}$
	T ; Lowest water temperature in monthly average ＝ 27 Celsius X_A ; 2,000 mg/l [SVI] ; Sluge density index ＝ 300
S	＝ 24.3 $m^3/m^2/d$ ＞ 20 $m^3/m^2/d$
Required Area for settling	＝ 59,800 ÷ 20 ＝ 2,990 m^2
No. of basin	＝ 16 basins
Required Area for one settling basin	＝ 2,990 ÷ 16 ＝ 187 m^2
Width	＝ 4.0 m (Standard : 3.0 ～ 4.0, Maximum 5.0m)
Length	＝ 47.0 m ＞ 12.0 m (Width × 3)
Effective Area	＝ 4.0 m × 47.0 m × 16 ＝ 3,008 m^2
Depth of basin	＝ 3.5 m
Overflow rate	
Maximum Daily Flowrate	＝ 59,800 m^3/d ÷ 3,008 m^2 ＝ 19.9 $m^3/m^2/d$
Maximum hourly Flowrate	＝ 72,800 m^3/d ÷ 3,008 m^2 ＝ 24.2 $m^3/m^2/d$
Settling Time	＝ (3,008 × 3.5 × 24) ÷ 59,800 ＝ 4.2 hrs
Weir Loading rate	＝ 120 $m^3/m/d$
Reqired Length of weir	＝ 59,800 m^3/d ÷ 16 ÷ 120 $m^3/m/d$ ＝ 31.1 m/basin

Item	Calculation
5. Disinfection	
5-1 Basin Volume	
Design Flowrate	
Maximum Daily Flowrate	= 59,800 m^3/d
Maximum hourly Flowrate	= 72,800 m^3/d
Contact Time	= 30 seconds
Req. Volume	= 72,800 ÷ 24 ÷ 60 ÷ 60 × 30
	= 25.3 m^3
Depth	= 1.5 m
Width	= 3.0 m (for 3 watercourses)
Length	= 8.0 m
Volume	= 1.5 × 3.0 × 8.0
	= 36 m^3

Item	Calculation
6. Sludge Treatment	
6-1 Sludge Thickening	
Solids (IN)	= 19.79 t/d
Solid Concentration	= 0.92 %
Sludge(IN)	= 2,145 m3/d
Solid Loading Rate	= 60 $kg/m^2/d$ (60 ~ $90kg/m^2/d$)
Req. Area	= 19.79 × 1,000 ÷ 60 = 329.8 m^2
No. of basin	= 4 basins
Reqired Area for one settling basin	= 329.8 ÷ 4 = 82.5 m^2
Diameter of basin	= 2×(83 ÷ π) ^ 0.5 = 10.3 → 11.0 m
Effective Area	= π /4× 11.0 ^ 2 × 4 = 380 m^2
Depth of basin	= 4.0 m (about 4.0m)
Overflow rate	= 19.8 t/d ÷ 380 m^2 × 1,000 = 52.1 $kg/m^2/d$
Settling Time	= (380.1 × 4.0 × 24) ÷ 2,145 = 17 hrs
6-2 Sludge Dewatering	
Solids (IN)	= 15.98 t/d
Solid Concentration	= 2.5 %
Sludge(IN)	= 640 m3/d
Operation Conditions	7 hrs in one day and 6 days in a week
Req. dewatering capacity	= 15.98 × 7 ÷ 6 ÷ 7 × 1,000 = 2,663 kg/hour
Solids loading	= 4.4 kg-ds/h/ ϕ 100
Diameter of dewatering	= 1,000 mm (Maximum 1,200mm)
Number	= 4
Dewatering capacity	= $(1000 / 100)^{2.2}$ × 4.4 × 4 = 2,789 kg/hour

Appendix 4-B2: Capacity Calculation of Sequencing Batch Reactor Process

Item	Calculation
1. Design Parameters	
1-1 Outline of Wastewater Treatment	
(1) Area of Plant	9.34 ha
(2) Grand Level of Plant	3.6 M
(3) Type of Collection System	Separate Sewer System
(4) Water Treatment Process	Sequencing Batch Reactor Process
1-2 Design Flowrate Waste Water	
(1) Average Daily Flowrate	52,000 m^3/d
(2) Maximum Daily Flowrate	59,800 m^3/d
(3) Maximum Hourly Flowrate	72,800 m^3/d
1-3 Influent Wastewater Quality Waste Water	
(1) BOD	200 mg/l
(2) COD_{Cr}	400 mg/l
(3) SS	250 mg/l
(4) T-N	41 mg/l
(5) T-P	6.4 mg/l
1-4 Design Influent Wastewater	
(1) BOD	275 mg/l → 280 mg/l
(2) COD_{Cr}	549 mg/l → 550 mg/l
(3) SS	304 mg/l → 310 mg/l
(4) T-N	56 mg/l → 60 mg/l
(5) T-P	7.8 mg/l → 8 mg/l
1-5 Removal Efficiency (Total System)	Total Treatment
(1) BOD	90 %
(2) COD_{Cr}	80 %
(3) SS	90 %
(4) T-N	70 %
(5) T-P	60 %
1-6 Effluent Wastewater Quality	
(1) BOD	28 mg/l ＜ 30 mg/l（Effluent Discharge Criteria）
(2) COD_{Cr}	110 mg/l ＜ - mg/l（Effluent Discharge Criteria）
(3) SS	31 mg/l ＜ 50 mg/l（Effluent Discharge Criteria）
(4) T-N	18 mg/l ＜ 30 mg/l（Effluent Discharge Criteria）
(5) T-P	3.2 mg/l ＜ 6.0 mg/l（Effluent Discharge Criteria）

Item	Calculation
Sludge Production (Maximum Daily Flowrate)	
1-7 Return Liquor (with Influent Wastewater)	Quantity = 2,761 m^3/day Quantity (DM)= 62,560 m^3/day
1-8 Waste Activated Sludge	Solids＝ DM × Influent SS × Removal Effciency SS×10^{-6} Solids＝ 62,560 m3/d × 310 mg/l × 90 %× 10^-6 ＝ 17.12 ds-t/d Solid Concentration ＝ 0.6 % Sludge ＝ Solids ÷ Solids Concentration×10^2 Sludge ＝ 17.12 t/d ÷ 0.6 % × 10^2 Sludge(OUT) ＝ 2,854 m^3/d
1-9 Thickening	Solids (IN) ＝ 17.12 ds-t/d Solids(OUT) ＝ WAS × Recovery Rate×10^{-2} Solids (OUT) ＝ 17.12 t/d × 85 % × 10^-2 Ricovery Rate ＝ 85 % ＝ 14.56 ds-t/d Sludge(OUT) ＝ Solids ÷ Solids Concentration×10^2 Sludge(OUT) ＝ 14.56 t/d ÷ 2 % × 10^2 Solid Concentration ＝ 2.0 % Sludge(OUT) ＝ 728 m^3/d
1-10 Dewatering	Solids (IN) ＝ 14.56 ds-t/d Solids(OUT) ＝ WAS × Recovery Rate×10^{-2} Solids (OUT) ＝ 14.56 t/d × 90 % × 10^-2 Ricovery Rate ＝ 90 % ＝ 13.11 ds-t/d Sludge(OUT) ＝ Solids ÷ Solids Concentration×10^2 Sludge(OUT) ＝ 13.11 t/d ÷ 16 % × 10^2 Solid Concentration ＝ 16 % Sludge(OUT) ＝ 82.0 m^3/d

1-11 Solids Mass Balance

Influent Wastewater		
Influent BOD	mg/l	200
Influent COD	mg/l	400
Influent SS	mg/l	250
Influent T-N	mg/l	41
Influent T-P	mg/l	6.4
Inflowrate	m3/d	59,800

Mixed Return Liquor		
Design Influent BOD	275	mg/l
Design Influent COD	549	mg/l
Design Influent SS	304	mg/l
Design Influent T-N	56	mg/l
Design Influent T-N	7.8	mg/l
Influent Solids	18.96	t/d

Return Liquor (RL = DW+FW)		
Solids	t/d	4.01
Solids Con.	%	0.15
RL Vol.	m3/d	2,761
BOD Loading	t/d	5.20
COD Loading	t/d	10.40
T-N Loading	t/d	1.04
T-P Loading	t/d	0.10

Treatment Unit		
Removal rate	%	90

Effluent Solids	t/d	1.900

Effluent

Rem.Solids	t/d	17.06
Solids Con.	%	0.6
Sludge Vol.	m3/d	2843

Thicking		
Rev. Rate	%	85

Thichning Sludge		
Solids	t/d	14.50
Solids Con.	%	2.0
Sluge Vol.	m3/d	725

Dewatering		
Rev. Rate	%	90

Dewatered Sludge		
Solids	t/d	13.05
Solids Con.	%	16.0
Sluge Vol.	m3/d	81.6

Disposed Place

Discharged Water (DW)		
Solids	t/d	2.56
Solids Con.	%	0.121
DW Vol.	m3/d	2,118
DW BOD	mg/l	2,000
DW BOD Loading	t/d	4.24
DW COD	mg/l	4,000
DW COD Loading	t/d	8.47
DW T-N	mg/l	400
DW T-N Loading	t/d	0.85
DW T-P	mg/l	40
DW T-P Loading	t/d	0.08

Filtered Water (FW)		
Solids	t/d	1.45
Solids Con.	%	0.226
FW Vol.	m3/d	643
FW BOD	mg/l	1,500
FW BOD Loading	t/d	0.96
FW COD	mg/l	3,000
FW COD Loading	t/d	1.93
FW T-N	mg/l	300
FW T-N Loading	t/d	0.19
FW T-P	mg/l	30
FW T-P Loading	t/d	0.02

Item	Calculation
2. Flow Equalization Tank	
2-1 Tank Volume	
Design Flowrate	
Maximum Daily Flowrate	= 59,800 m^3/d
Maximum hourly Flowrate	= 72,800 m^3/d
Retention Time	= 6.0 hours
Req. Volume	= 6.0 ／ 24.00 × 59,800 = 14,950
Number of Series	= 4 Series
Number of Basin	= 1 Basin
One reactor Volume	= 14,950 / 4 / 1 = 3,740 m^3
Total Water Depth	= 5.0 m
Width	= 28.0 m
Length	= 3,740 ／(28.0 × 5.0 ）≒ 27.0 m
Total Volume	= 5.0 × 28.0 × 27.0 = 3,780 m^3/Series
Total Pomp Capacity	= 59,800 m^3/day = 41.53 m^3/min
Pump Numbers	= 5 pumps (Including Backup Pump)
Pump Capaccity	= 41.53 / 4 = 10.4 m^3/min

Item	Calculation
3. Sequencing Batch Reactor	
3-1 Reactor Volume	
Design Flowrate	
Maximum Daily Flowrate	= 59,800 m^3/d
Maximum hourly Flowrate	= 72,800 m^3/d
Drainage Ratio	= 0.333
Number of Cycle	= 3
Hydraulic Detention Time	= 24 ／(0.333 × 3)= 24 hours
Req. Volume	= 59,800 m^3/d × 24 hrs ÷ 24 = 59,800 m^3
Number of Series	= 4 Series
Number of Reactor	= 4 Reactors / Series
One reactor Volume	= 59,800 / 4 / 4 ≒ 3,740 m^3
Total Water Depth	= 5.5 m
Width	= 27.0 m
Length	= 3,740 ／(27.0 × 5.5)≒ 26.0 m
Size of Reactor	
Process	Sequencing Batch Reactor
Width	= 27.0 m
Length	= 26.0 m
Water Depth	= 5.5 m
Volume	= 3,861 m^3/reactor > 3,740 m^3 ・・・ OK
Cycle Time	Tc = 24 / 3 = 8.0 hours
Number of Reactor	N = 4 Reactors / Series
Inflow Time	Tf = 8.0 / 4 = 2.0 hours
Aeration and Mixing Time	Ta = 4.0 hours
MLSS	C_A = 3,000 mg/l
Water Temperature	t = 23 ℃
Sedimentation Rate of Sludge	Vmax = 7.4 $\times 10^4 \times$ 23 × $3,000^{-1.7}$ = 2.09 m/hour
Interval Time	Tr = 0 hours
Sedimentation Time	Ts = (5.5 × 0.333 + 0.5) / 2.09 = 1.12 hours
Discharge Time	Td = 2.0 hours

Item	Calculation
Condition Check	Tc ＝ 8.0 ≧ Tr＋Ta＋Ts＋Td ＝ 7.12 ・・・ OK
	Ts＋Td ＝ 3.12 ≦ Tc－Tf ＝ 6.00 ・・・ OK
3-2 Aerator	
(1) Design Parameters	
Maximum Daily Flowrate	＝ 59,800 m^3/d
Influent BOD	＝ 280 mg/l
Influent S-BOD	＝ 140 mg/l
Influent SS	＝ 310 mg/l
Influent Kj-N	＝ 60 mg/l
MLSS	＝ 3,000 mg/l
Aerobic volume ratio	＝ 0.5 ＝ 4.0 hours ／ 8.0 hours
HRT	＝ 24 hours
(2) Organic Loading Rate	
Organic Loading Rate	$= \dfrac{X_I \text{ x } Q}{X_A \text{ x } V}$
	V ; Reactor Volume, m^3
	Q ; Maximum Daily Flowrate/Reactor
	＝ 59,800 ÷ 4 ÷ 4 ＝ 3,738 m^3/d
	X_I ; Influent BOD ＝ 280 mg/l
	X_A ; MLSS
	$= \dfrac{280 \text{ x } 3{,}738}{3{,}000 \text{ x } 3{,}861}$ ＝ 0.09 kg/BOD/d/kgMLSS
(3) SRT or ASRT SRT	$= \dfrac{\tau \cdot X_W}{a \cdot C_{S\text{-}BODin} + b \cdot C_{SS.in} - c \cdot \tau \cdot X_W}$
	SRT ; Sludge Retention Time
	τ ; Hydraulic Detention Time ＝ 1.000 days
	X_w ; MLSS, mg/l ＝ 3,000 mg/l
	$C_{S\text{-}BOD.in}$; Influent Soluble BOD in reactor
	＝ 140 mg/l
	$C_{SS.in}$; Influent SS in reactor ＝ 310 mg/l
	a ; Rate of Sludge coversion from S-BOD
	＝ 0.5 gMLSS/gS-BOD
	b ; Rate of Sludge production from SS
	＝ 0.95 gMLSS/gSS
	c ; Decay rate ＝ 0.04 1/d
SRT	$= \dfrac{1.000 \times 3{,}000}{0.50 \times 140 + 0.95 \times 310 - 0.04 \times 1.000 \times 3{,}000}$
	＝ 12.27 day
ASRT	＝ SRT × Ta ／ Tc
	＝ 12.3 × 0.5 ＝ 6.14 days
	ASRT ; Aerobic Sludge Retention Time
(4) Empirical ASRT	ASRT > 20.65 EXP (-0.0639 × T)
	T ; Lowest water temperature in monthly average
	＝ 23 Celsius
ASRT	＝ 20.65 exp (-0.0639 × 23)
	＝ 4.75 days < 6.14 days ・・・ OK

Item	Calculation
(5) Prediction of C-BOD based on ASRT	C-BOD : Carbonacious BOD
C-BOD	＝ 10.42 × ASRT ^ -0.519
	＝ 10.42 × 6.14 ^ -0.519
	＝ 4.07 mg/l
	Assumming BOD/C-BOD is 3.0
BOD	＝ 3 × C-BOD
	＝ 3 × 4.07
	＝ 12.3 mg/l < 20 mg/l ・・・ OK
(6) Oxigen requirement for BOD oxidation	
OD1	＝ A × (Removed BOD － Denitrified N × K)
	A ; Reqired O_2/Removed BOD
	＝ 0.6 kg as O_2/kg as BOD
	K ; Consumed BOD by Denitrification
	＝ 2.0 kg as BOD/kg as N
	Removed BOD ＝ 0.280 × 59,800
	＝ 16,744 kg as BOD/d
	Denitrified N ; Assuming all nitrified N is denitrified.
OD1	＝ 0.6 × (16,744 － 3588 × 2.0)
	＝ 5,741 kg as O_2/d
(7) Oxigen requirement for Internal respiration	
OD2	＝ B × Va × MLVSS
	B ; O_2 Volume for internal aspiration
	＝ 0.10 kg as O^2/kg as MLVSS/d
	Va ; Aerobic zone volume
	= Volume ÷ 2
	Assuming MLVSS/MLSS is 0.8
OD2	＝ 0.1 × 61,776 ÷ 2 × 3.0 × 0.8
	＝ 7,413 kg as O_2/d
(8) Oxigen requirement for nitrification	
OD3	＝ C × Nitrified N
	C ; O_2 consumed by nitrification
	＝ 4.57 kg as O_2/kg as N
	Nitrified N ; Amount of nitrifired nitrogen
	; Influent N － Effluent no nitrified N
	－ nitrogen of WAS
	Influent N ; 0.060 × 59,800
	＝ 3,588 kg as N/d
	Effluent no-N ; Assuming all N is nitrified
	Nitrogen of WAS ＝ 0.08 (kg as N/kg as MLSS)
	× Qw×Xx
	$Q_W \times X_X = Q_{in}(a \times C_{S-BOD,in} + b \times C_{ss,in} - c \times X_A \times \tau_A) \times 10^{-3}$
	τ_A ; Aeration time ＝ 24.0 / 24.0 × 0.5
	＝ 0.500 d

Item	Calculation
	Qw×Xa ＝ 59,800 × (0.5 × 140 + 0.95 × 310 − 0.04 × 3,000 × 0.5)× 10^-3
	＝ 18,209 kg/d
	Nitrogen of WAS ＝ 0.08 × 18,209
	＝ 1456.8 kg as N/d
OD3	＝ 4.57 ×(3588 − 0 − 1,457)
	＝ 9,740 kg as O_2/d
(9) Oxigen requirement in Effluent	
OD4	＝ Oxigen in effluent
	＝ 1.5 × 59,800 × 10^-3
	＝ 90 kg as O_2/d
(10) Actual Oxigen Requirement	
AOR	＝ OD_1 + OD_2 + OD_3 + OD_4
	＝ 5,741 + 7,413 + 9,740 + 90
	＝ 22,984 kg as O_2/d
(11) Standard Oxigen Requirement	
SOR	＝ $\frac{AOR \times C_{SW}}{1.024^{(t-20)} \times \alpha \times (\beta \times C_S \cdot r - C_a)} \times \frac{760}{P}$
	C_{SW} ; Oxygen saturation concentration in clean water at 20 Celsius ＝ 8.84 mg/l
	Ca ; Average DO ＝ 1.5 mg/l
	Cs ; Oxygen saturation concentration in clean water at t Celsius ＝ 8.39 mg/l; t = 23 Celsius
	r ; Coefficient of water depth: r ＝ $1 + \frac{(H/2)}{10.332}$ ＝ 1.18
	H ; Average depth of air diffuser = 3.63 m
	α ; 0.93
	β ; 0.97
	P ; 760 (0 meter above sea level)
SOR	＝ 25,225 kg as O_2/d
	＝ 25,225 ÷ 12 hr ＝ 2,102.1 kg as O_2/hr
	＝ 2,102.1 ÷ 60 min ＝ 35.0 kg as O_2/min
	Required Oxygen ＝ $\frac{25,225}{0.28 \times 59,800}$ ＝ 1.6 kg as O_2/kg as BOD

Appendix 4-C

Consideration of SBR and CAS

SBR Type selection

SBR process is an unique process to conduct aeration and sedimentation in one tank although CAS and other processes conduct aeration and sedimentation in different tanks. Basically SBR is conducted by fill and draw operation in “Batch”. Recently SBR with continuous flow is developed. It has an advantage on small space requirement because of no equalization tank. In this section, the type of SBR selected is explained.

(1) Required Treated Water Quality

Effluent quality for STP is determined by Environmental Impact Assessment (EIA) report of the project on sewerage and wastewater treatment for Bien Hoa City approved in October 2008. Water qualities requirement in EIA are shown as Table A4-C-1. In terms of nitrogen, requirements are 5 mg/l of ammonia nitrogen, 30 mg/l of nitrate nitrogen and 35mg of total nitrogen (ammonia nitrogen + nitrate nitrogen).

Table A4-C-1 Water Quality in EIA

No.	Item	Unit	A
1.	pH		5 - 9
2.	BOD_5 (20 ^oC)	mg/l	30
3.	Total suspended solids (TSS)	mg/l	50
4.	Total dissolved solids (TS)	mg/l	500
5.	Sulfide (H_2S)	mg/l	1
6.	Ammonia nitrogen (NH_4^+-N)	mg/l	5
7.	Nitrate-nitrogen (NO_3^--N)	mg/l	30
8.	Mineral oil, vegetable oil	mg/l	10
9.	Total surface-active substances	mg/l	5
10.	Phosphate phosphorus (PO_4^{3-}-P)	mg/l	6
11.	Total coliforms	MPN/100ml	3000

A: apply for discharge into the resource which is used for water treatment plant

(2) Treated Water Quality of SBR with batch flow

The typical treated water quality of SBR with batch flow is presented in Table A4-C-2. When the aerobic and anaerobic conditions are completely ensured by batch operation, SBR can reduce total nitrogen to 15 mg/L and ammonia nitrogen to 5 mg/L. SBR with batch flow can meet water quality of EIA.

Table A4-C-2 Removal Efficiency of SBR

Item	Removal Efficiency(1)	Effluent Quality
BOD_5	Over 90%	Under 30 mg/l for influent 300mg/l
SS	Over 90%	Under 30 mg/l for influent 300mg/l
T-N	About 70%	Under 15 mg/l for influent 50mg/l
Ammonia-nitrogen	Over 90%	Under 5 mg/l for influent 50mg/l

Source: (1) Japanese Design Guide Manual

(3) Treated Water Quality of SBR with continuous flow

The treated water quality of SBR with continuous flow is presented in Table A4-C-3. Treated total nitrogen is below 15 mg/l in the cases of Run 1 and Run 2. In the Run 3 case, total nitrogen is over 15 mg/l. On the ammonia nitrogen, SBR with continuous flow cannot achieve 5 mg/l of ammonia nitrogen in effluent. Continuous flow cannot conduct nitrification completely because sewage inflows continuously to reactor during settling and discharging period, when aeration is stopped.

Table A4-C-3 Removal Efficiency of SBR with continuous flow

Item	Influent	Effluent (mg/l)			Removal Efficiency		
		Run1	Run 2	Run 3	Run 1	Run 2	Run 3
BOD	230	5.2	6.2	7.3	97.7%	97.3%	96.8%
SS	255	2.6	5.6	8.4	99.0%	97.8%	96.7%
T-N	48.7	14.0	14.7	20.3	71.2%	69.8%	58.3%
Ammonia-nitrogen	47.9	7.1	8.3	14.6	85.2%	82.7%	69.5%
T-P	16.1	9.7	7.9	7.3	39.8%	43.7%	54.7%

Source: American Journal of Applied Sciences 1 (4): 348-353, 2004
Note: Retention Time：Run1=16.7 hours, Run2=14 hours, Run3=12.4 hours

(4) Type of SBR

Based on the ammonia nitrogen removal requirement, SBR with continuous flow cannot meet water quality required by EIA. Therefore, batch flow is selected as SBR process.

Comparison of Electric Power Consumption between SBR and CAS

Electric consumptions of SBR and CAS processes are calculated based on the power consumption of main equipment for each process. Table A4-C-4 and A4-C-5 present the electric consumptions of SBR and CAS. The main differences of electric consumptions are due to consumptions for flow control pump and mixers for equalization tank and reactor of SBR.

Flow control pumps of SBR are used for sending sewage from equalization tank to reactor. Mixers for equalization tank are used for the prevention of sedimentation of suspended solids.

Since CAS does not have equalization tank, flow control pump or mixer is not necessary.

Mixers for reactor are used for nitrogen removal by mixing microorganisms and nitrate. Four mixers are installed for one reactor. Because SBR process has 16 reactors, 64 mixers are installed. In CAS process, 16 mixers are installed because of 4 reactors.

Table A4-C2-4 Electric Consumption of SBR

Item	Quantity	Power (kW)	Time (H/D)	Loading Factor	Used Electric Power (kWH/day)
Mixer for Equalization Tank	16	4.0	24	0.8	1,229
Flow Control Pump	4	22.0	24	0.8	1,690
Mixer for Reactor	64	5.0	12	0.8	3,072
Blower	4	155.0	24	0.8	11,904
Decanter for discharge	64	0.2	6	0.8	61
Scum Separator	2	1.5	4	0.8	10
Sludge Pump	8	7.5	4	0.8	192
Inflow Switching Valve	16	0.8	0.2	0.8	2
Air Switching Valve	16	0.2	0.2	0.8	1
Total					18,161

Table A4-C-5 Electric Consumption of CAS

Item	Quantity	Power (kW)	Time (H/D)	Loading Factor	Used Electric Power (kWH/day)
Sludge Collector for Primary sedimentation	16	0.8	24	0.8	230
Primary Sludge Pump	4	5.5	3	0.8	53
Switching Valve for Primary Sludge	16	0.2	1	0.8	1
Scum Skimmer	16	0.2	1	0.8	1
Mixer	16	5.0	24	0.8	1,536
Blower	4	155.0	24	0.8	11,904
Sludge Collector for Final sedimentation	16	2.2	24	0.8	676
Switching Valve for Excess Sludge	16	0.2	1	0.8	1
Excess Sludge Pump	4	7.5	6	0.8	144
Returned Sludge Pump	4	5.5	24	0.8	422
Total					14,968

Layout Plan of SBR and CAS

The total sewage flow of STP2 is 91,500 m^3/day in rainy season in 2030. Based on the layout of SBR, the maximum capacity of SBR at present STP2 site could be 70,000 m^3/day when the depth of reactor tank is 6m.

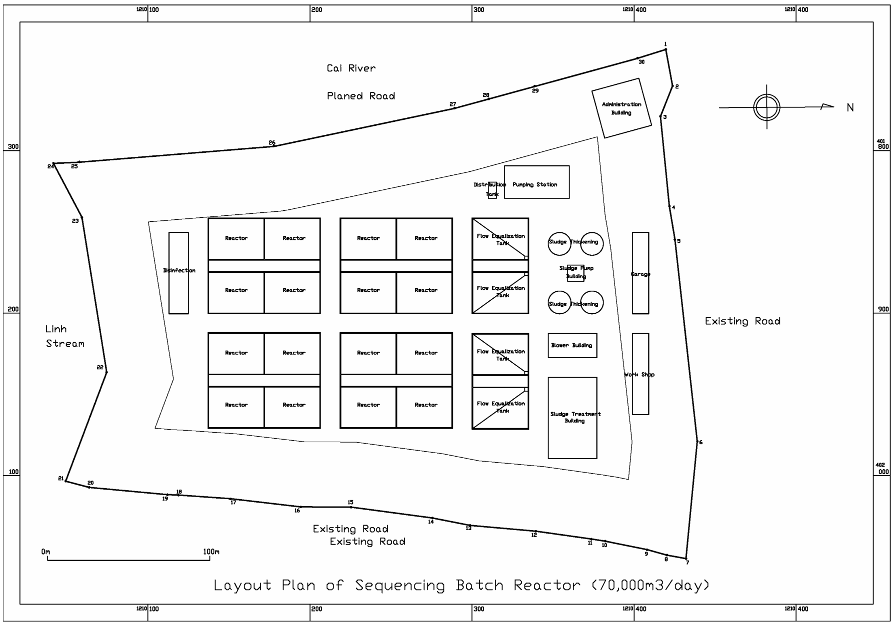


Figure A4-C-1 70,000m^3/day SBR Facilities at STP 2 Site

If the remaining 21,500 m^3/d is to be treated by SBR, about 36,600m^2 (170m ×215m) of area will berequired in 2030. Figure A4-C-2 presents the layout of 21,500 m^3/d of SBR STP.

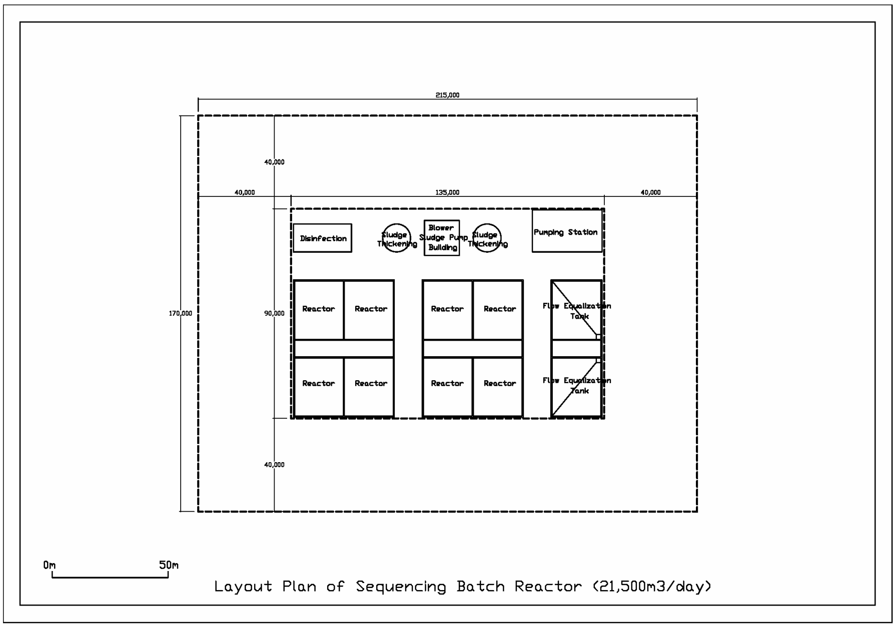


Figure A4-C-2 The SBR Facilities for capacity of 21,500m^3/day

On CAS, all sewage, 91,500m^3/day could be treated at present STP2 site. The layout of CAS is presented in Figure A4-C-3.

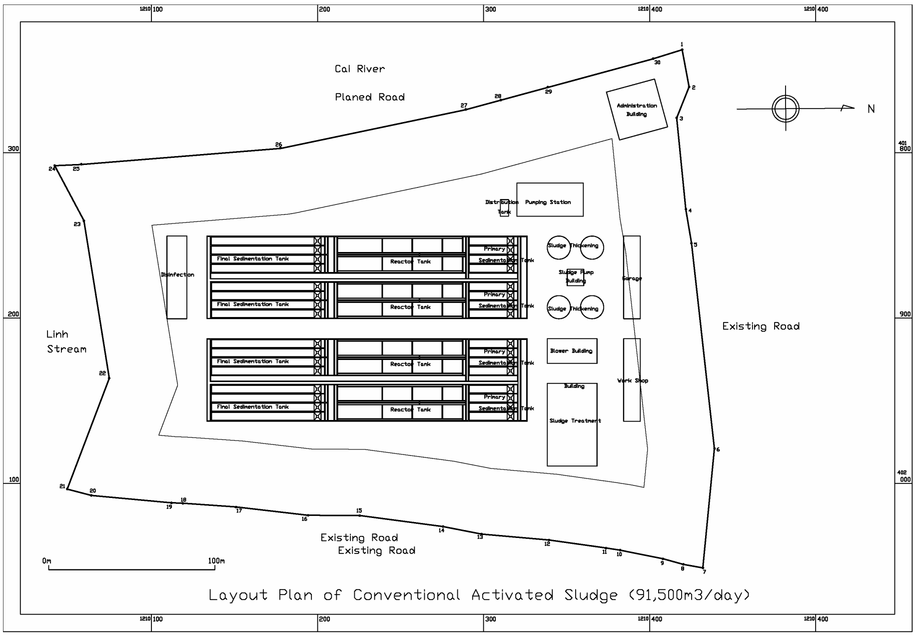
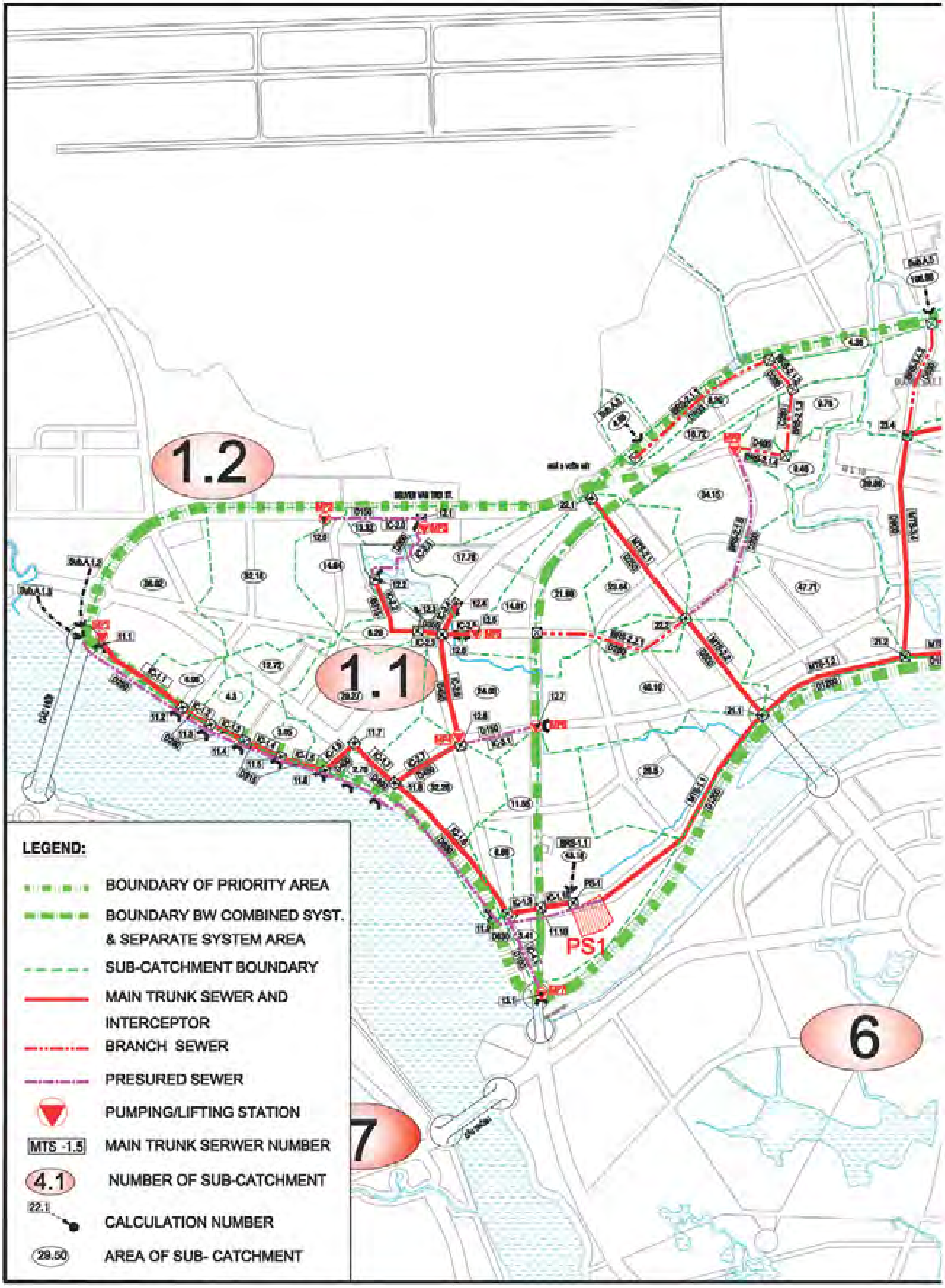
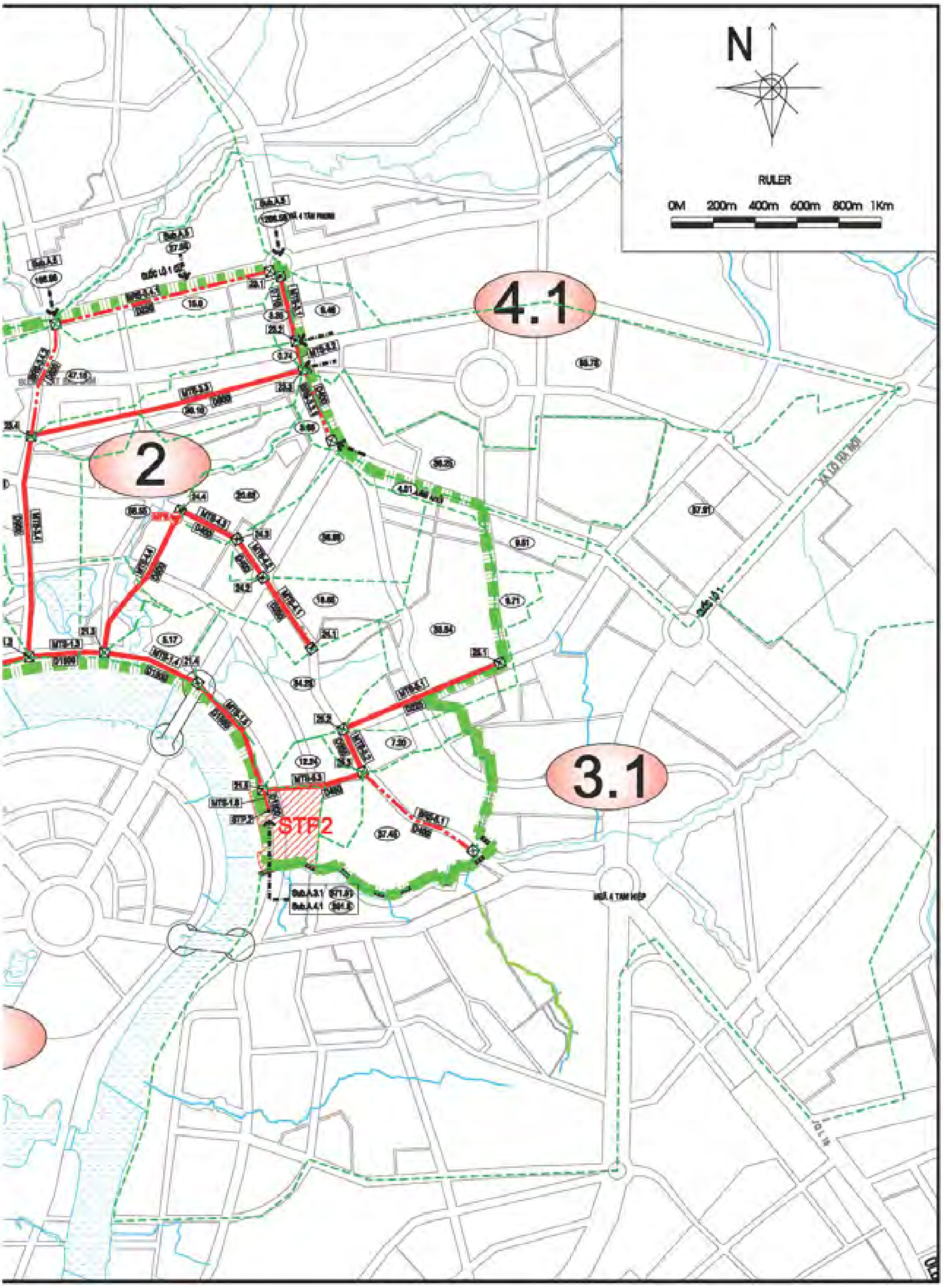


Figure A4-C-3 The CAS Facilities for capacity of 91,500m^3/day

Appendix 5-A

Plan Drawing of Sewerage System


1.2
1.1
6
7
PS1
LEGEND:
BOUNDARY OF PRIORITY AREA
BOUNDARY BW COMBINED SYST. & SEPARATE SYSTEM AREA
SUB-CATCHMENT BOUNDARY
MAIN TRUNK SEWER AND INTERCEPTOR
BRANCH SEWER
PRESURED SEWER
PUMPING/LIFTING STATION
MTS -1.5
MAIN TRUNK SERWER NUMBER
4.1
NUMBER OF SUB-CATCHMENT
22.1
CALCULATION NUMBER
29.50
AREA OF SUB- CATCHMENT


N
RULER
0M 200m 400m 600m 800m 1Km
4.1
2
3.1
STP2

Appendix 5-B

Hydraulic Calculation Sheet of Sanitary Sewer

Year 2020 (Entire Service Area)

Section: Start point	End Point	Sewer No.	Length (m)	Size of Catchment Area (ha): 1.1	1.2	1.3	2	3.1	3.2	4.1	5	Total Area (ha)	Population Density & Population (persons/ha, persons): 1.1	1.2	1.3	2	3.1	3.2	4.1	5	Total population (persons)
Combined System													233								
Separate System														233	137	179	143	143	100	62.7	
11.1	11.2	IC-1.1	485	36.02								36.02	8,378								8,378
11.2	11.3	IC-1.2	155	6.96								6.96	1,620								1,620
11.3	11.4	IC-1.3	180	4.30								4.30	999								999
11.4	11.5	IC-1.4	193	12.72								12.72	2,959								2,959
11.5	11.6	IC-1.5	224	3.05								3.05	710								710
11.6	11.7	IC-1.6	146	29.27								29.27	6,809								6,809
11.7	11.8	IC-1.7	290	2.76								2.76	641								641
11.8	11.9	IC-1.8	821	32.26								32.26	7,505								7,505
11.9	11.10	IC-1.9	215	6.66								6.66	1,548								1,548
11.10	PS-1	IC-1.10	158	11.55								11.55	2,687								2,687
12.00	12.10	IC-2.0	447	32.18								32.18	7,485								7,485
12.1	12.2	IC-2.1	520	13.32								13.32	3,098								3,098
12.2	12.3	IC-2.2	385	14.64								14.64	3,404								3,404
12.3	12.6	IC-2.3	120	6.29								6.29	1,463								1,463
12.6	12.7	IC-2.6	553	0.00								0.00									0
12.7	11.10	IC-2.7	370	0.00								0.00									0
12.4	12.6	IC-2.4	140	17.78								17.78	4,135								4,135
12.5	12.6	IC-2.5	153	14.81								14.81	3,446								3,446
12.7	12.8	IC-3.1	338	24.03								24.03	5,590								5,590
13.1	11.10	IC-4.1	402	3.41								3.41	793								793
	PS-1	BRS-1.1	0				43.18					43.18				7,722					7,722
PS-1	TOTAL											0.00									
PS-1	21.1	MTS-1.1	1214		76.00	212.00	28.50					316.50		17,678	29,053	5,097					51,828
21.1	21.2	MTS-1.2	752				47.71					47.71				8,532					8,532
21.2	21.3	MTS-1.3	362									0.00									
21.3	21.4	MTS-1.4	475				5.17					5.17				925					925
21.4	21.5	MTS-1.5	605				34.23					34.23				6,121					6,121
21.5	STP2	MTS-1.6	20																		

Start point	End Point	Sewer No.	Sewage Flow: Unit Flow/Q ave (l/cap/sec, l/sec)	Accumulated Qave (l/sec)	Peak factor	Combined K	Peak flow (l/sec)	Flow from upstream (l/sec)	Q total (l/sec)	Pump point (l/sec)	Q grand Total (l/sec)	Capacity of Pipe: DN (mm)	Di (mm)	Slope (m/m)	Velocity (m/sec)	Quantity m^3/s	Ground level: Begin (m)	End (m)	Invert level: Begin (m)	End (m)	Sewer depth: Begin (m)	End (m)	Remarks
Combined System			0.001829																				
Separate System			0.001979																				
11.1	11.2	IC-1.1	15.32		2.00	2.00	30.65		30.65		30.65	250	231	0.0040	0.86	0.036	3.99	3.99	2.50	0.56	1.49	3.43	MP
11.2	11.3	IC-1.2	2.96		2.50	2.00	7.41	30.65	38.06		38.06	280	259	0.0040	0.93	0.049	3.99	3.98	0.53	-0.09	3.46	4.07	
11.3	11.4	IC-1.3	1.83		2.50	2.00	4.57	38.06	42.63		42.63	280	259	0.0040	0.93	0.049	3.98	2.86	-0.26	-0.98	4.24	3.84	PJ(900)
11.4	11.5	IC-1.4	5.41		2.50	2.00	13.53	42.63	56.16		56.16	315	291	0.0033	0.91	0.061	2.86	3.28	-0.94	-1.58	3.80	4.86	PJ(900)
11.5	11.6	IC-1.5	1.30		2.50	2.00	3.25	56.16	59.41		59.41	315	291	0.0033	0.91	0.061	3.28	3.09	-1.58	-2.32	4.86	5.41	PJ(900)
11.6	11.7	IC-1.6	12.45		2.05	2.00	25.53	59.41	84.94		84.94	400	369	0.0025	0.93	0.099	3.09	2.80	-2.41	-2.77	5.5	5.57	PJ(900)
11.7	11.8	IC-1.7	1.17		2.50	2.00	2.93	84.94	87.87		87.87	400	369	0.0025	0.93	0.099	2.80	3.14	-2.77	-3.49	5.57	6.63	PJ(900)
11.8	11.9	IC-1.8	13.73		2.02	2.00	27.73	205.30	233.03		233.03	630	582	0.0017	1.04	0.276	3.14	4.20	-3.72	-5.12	6.86	9.32	PJ(900)
11.9	11.10	IC-1.9	2.83		2.50	2.00	7.08	236.65	243.73		243.73	630	582	0.0017	1.04	0.276	4.20	4.06	-5.12	-5.48	9.32	9.54	PJ(900)
11.10	PS-1	IC-1.10	4.91		2.50	2.00	12.28	243.73	256.01		256.01	630	582	0.0017	1.04	0.276	4.06	2.60	-5.48	-5.75	9.54	8.35	PJ(900)
12.00	12.10	IC-2.0	13.69		2.02	2.00	27.65		27.65		27.65	150	208	-0.0025	-	-	2.40	3.50	1.25	2.35	1.15	1.15	MP
12.1	12.2	IC-2.1	5.67		2.50	2.00	14.16	27.65	41.81		41.81	200	-	0.0012	-	-	3.50	2.89	2.30	1.69	1.20	1.20	MP
12.2	12.3	IC-2.2	6.23		2.40	2.00	14.94	41.81	56.75		56.75	315	291	0.0033	0.91	0.061	2.89	2.32	1.40	0.13	1.49	2.19	
12.3	12.6	IC-2.3	2.68		2.50	2.00	6.69	56.75	63.44		63.44	355	328	0.0030	0.94	0.079	2.32	2.32	-0.04	-0.40	2.36	2.72	
12.6	12.7	IC-2.6	0.00			2.00	0.00	95.96	95.96		95.96	450	416	0.0022	0.94	0.128	2.32	2.18	-1.82	-3.04	4.14	5.22	
12.7	11.10	IC-2.7	0.00			2.00	0.00	117.43	117.43		117.43	450	416	0.0022	0.94	0.128	2.18	4.20	0.73	0.07	1.45	4.13	MP
12.4	12.6	IC-2.4	7.56		2.30	2.00	17.39		17.39		17.39	200	185	0.0050	0.83	0.022	2.57	2.32	0.28	0.42	2.29	1.90	
12.5	12.6	IC-2.5	6.30		2.40	2.00	15.13		15.13		15.13	200	185	0.0050	0.83	0.022	2.40	2.32	1.20	0.44	1.20	1.88	MP
12.7	12.8	IC-3.1	10.22		2.10	2.00	21.47		21.47		21.47	150	-	-0.0060	-	-	2.17	2.18	1.00	1.23	1.17	0.95	MP
13.1	11.10	IC-4.1	1.45		2.50	2.00	3.62		3.62		3.62	100	-	-0.0025	-	-	3.19	4.20	2.09	3.10	1.10	1.10	MP
	PS-1	BRS-1.1	15.28	15.28	2.00		30.56		30.56														
PS-1	TOTAL							256.01	256.01	286.57													
PS-1	21.1	MTS-1.1	102.57	102.57	1.60		164.11		164.11	286.57	450.68	1200	1059	0.0010	1.19	1.044	2.60	2.10	-0.60	-3.82	3.20	5.92	
21.1	21.2	MTS-1.2	16.88	178.88	1.58		282.63		282.63	286.57	569.20	1200	1059	0.0010	1.19	1.044	2.10	2.10	-3.82	-4.57	6.04	6.79	PJ
21.2	21.3	MTS-1.3		445.11	1.51		672.12		672.12	286.57	958.69	1500	1500	0.0010	1.26	2.235	2.10	2.10	-4.87	-5.23	7.09	7.45	PJ
21.3	21.4	MTS-1.4	1.83	493.94	1.50		740.91		740.91	286.57	1027.48	1500	1500	0.0010	1.26	2.235	2.10	2.10	-5.23	-5.71	7.45	7.93	PJ
21.4	21.5	MTS-1.5	12.11	506.05	1.50		759.08		759.08	286.57	1045.65	1500	1500	0.0010	1.26	2.235	2.10	2.10	-5.71	-6.32	7.93	8.54	PJ
21.5	STP2	MTS-1.6		808.61	1.48		1195.93		1195.93	286.57	1482.50	1500	1500	0.0010	1.26	2.235	2.10	2.10	-6.32	-6.34	8.54	8.56	PJ
										Peak Flow at STP2 Route	128,088	(m^3/day)	(round: 128,100 m^3/day)										

Section: Start point	Section: End Point	Sewer No.	Length	Size of Catchment Area: 1.1	1.2	1.3	2	3.1	3.2	4.1	5	Total Area	Population Density & Population: 1.1	1.2	1.3	2	3.1	3.2	4.1	5	Total population
			(m)	(ha)								(ha)	(persons/ha, persons)								(persons)
Combined System													233								
Separate System														233	137	179	143	143	100	62.7	
22.1	22.2	MTS-2.1	732				23.64					23.64				4,227					4,227
22.2	21.1	MTS-2.2	590				40.10					40.10				7,171					7,171
23.1	23.2	MTS-3.1	322				3.35			9.46	1,206.60	1,219.41				599			942	75,623	77,164
23.2	23.3	MTS-3.2	140				0.74			65.78		66.52				132			6,551		6,683
23.3	23.4	MTS-3.3	1340				30.10					30.10				5,382					5,382
23.4	21.2	MTS-3.4	1041				39.88					39.88				7,131					7,131
24.1	24.2	MTS-4.1	400				18.65					18.65				3,335					3,335
24.2	24.3	MTS-4.2	200				36.98					36.98				6,613					6,613
24.3	24.4	MTS-4.3	300				20.63					20.63				3,690					3,690
24.4	21.3	MTS-4.4	765				56.55					56.55				10,113					10,113
25.1	25.2	MTS-5.1	817				35.54	9.71				45.25				6,355	1,387				7,742
25.2	25.3	MTS-5.2	234				7.20					7.20				1,288					1,288
25.3	21.5	MTS-5.3	495				12.24					12.24				2,189					2,189
Sub-catch 3.1, 4.1	21.5							671.78		391.60		1,063.38					95,968		38,999		134,967
Sub-catch 3.2	S TP 3								569			569.00						81,286			81,286
BRS-2.1.1		BRS-2.1.1	792				8.39				4.88	13.27				1,501				306	1,807
BRS-2.1.2		BRS-2.1.2	167				18.72					18.72				3,348					3,348
BRS-2.1.3		BRS-2.1.3	322				9.76					9.76				1,746					1,746
BRS-2.1.4		BRS-2.1.4	247				9.46					9.46				1,692					1,692
BRS-2.1.5		BRS-2.1.5	914				34.15					34.15				6,107					6,107
BRS-2.2.1		BRS-2.2.1	751				21.99					21.99				3,932					3,932
BRS-3.3.1		BRS-3.3.1	385				8.17	9.51		94.16		111.84				1,461	1,359		9,377		12,197
BRS-3.4.1		BRS-3.4.1	1032				15.00				27.54	42.54				2,682				1,726	4,408
BRS-3.4.2		BRS-3.4.2	556				51.54				196.98	248.52				9,217				12,346	21,563
BRS-5.1		BRS-5.1	630				37.45					37.45				6,697					6,697
Total				273	77	213	701	694	572	565	1,441	4,516.01	63,502	17,912	29,191	125,184	98,860	81,432	55,973	90,068	560,871

Start point	Sewage Flow: Unit Flow/Q ave	Accumulated Qave	Peak factor	Combined K	Peak flow	Flow from upstream	Q total	Pump point	Q grand Total	Capacity of Pipe: DN	Di	Slope	Velocity	Quantity	Ground level: Begin	End	Invert level: Begin	End	Sewer depth: Begin	End	Remarks
	(l/cap/sec, l/sec)	(l/sec)			(l/sec)	(l/sec)	(l/sec)	(l/sec)	(l/sec)	(mm)	(mm)	(m/m)	(m/sec)	m^3/s	(m)	(m)	(m)	(m)	(m)	(m)	
Combined System	0.001829																				
Separate System	0.001979																				
22.1	8.37	8.37	2.20		18.41		18.41		18.41	250	235	0.0060	1.06	0.046	8.00	4.60	5.75	1.36	2.25	3.24	
22.2	14.19	59.43	1.68		99.84		99.84		99.84	500	475	0.0026	1.12	0.198	4.60	2.10	-0.13	-1.66	4.73	3.76	
23.1	152.71	152.71	1.59		242.80		242.80		242.80	710	626	0.0033	1.52	0.467	10.53	9.80	7.82	6.76	2.71	3.04	
23.2	13.23	165.93	1.58		262.17		262.17		262.17	800	705	0.0035	1.69	0.660	9.80	9.37	6.76	6.18	3.04	3.19	
23.3	10.65	200.72	1.57		315.13		315.13		315.13	900	793	0.0030	1.69	0.837	9.37	6.30	6.06	2.06	3.31	4.24	
23.4	14.11	266.23	1.56		415.32		415.32		415.32	900	793	0.0030	1.69	0.837	6.30	2.10	1.16	-1.96	5.14	4.06	
24.1	6.60	6.60	2.40		15.84		15.84		15.84	250	231	0.0040	0.86	0.036	4.71	4.17	0.46	-1.14	4.25	5.31	PJ(900)
24.2	13.09	19.69	1.91		37.60		37.60		37.60	400	377	0.0025	0.94	0.105	4.17	5.66	-1.29	-1.79	5.46	7.45	PJ(900)
24.3	7.30	26.99	1.84		49.66		49.66		49.66	400	377	0.0025	0.94	0.105	5.66	3.16	-1.79	-2.54	7.45	5.70	PJ(900)
24.4	20.01	47.00	1.71		80.37		80.37		80.37	500	475	0.0020	0.98	0.174	3.16	2.10	0.66	-0.87	2.50	2.97	MP
25.1	15.32	15.32	2.00		30.64		30.64		30.64	225	212	0.0210	1.86	0.066	27.50	11.00	25.28	8.12	2.22	2.88	
25.2	2.55	17.87	1.94		34.67		34.67		34.67	355	328	0.0150	2.10	0.178	11.00	7.30	6.46	2.95	4.54	4.35	PJ(900)
25.3	4.33	35.46	1.79		63.46		63.46		63.46	450	416	0.0022	0.94	0.128	7.30	2.60	2.85	0.15	4.45	2.45	PJ(900)
Sub-catch 3.1, 4.1	267.10	267.10	1.56		416.68		416.68		416.68												
Sub-catch 3.2	160.86	160.86	1.59		255.37		255.37		255.37												
BRS-2.1.1	3.58	3.58	2.50		8.94		8.94		8.94	200	188	0.005	0.84	0.023	10.38	5.00	6.76	2.80	3.62	2.20	
BRS-2.1.2	6.62	10.20	2.10		21.42		21.42		21.42	280	264	0.005	1.05	0.057	5.00	3.97	2.53	1.69	2.47	2.28	
BRS-2.1.3	3.45	13.66	2.03		27.72		27.72		27.72	280	264	0.005	1.05	0.057	3.97	2.30	1.63	0.02	2.34	2.28	
BRS-2.1.4	3.35	17.00	1.96		33.33		33.33		33.33	400	377	0.0025	0.94	0.105	2.30	3.00	-0.10	-0.72	2.40	3.72	
BRS-2.1.5	12.09	29.09	1.83		53.23		53.23		53.23	200	-	-0.0018	-	-	3.00	4.60	1.80	3.40	1.20	1.20	MP
BRS-2.2.1	7.78	7.78	2.30		17.90		17.90		17.90	280	264	0.0035	0.88	0.048	5.00	4.60	2.72	0.09	2.28	4.51	
BRS-3.3.1	24.14	24.14	1.87		45.14		45.14		45.14	400	377	0.0030	1.03	0.115	11.25	9.37	8.13	6.97	3.12	2.40	
BRS-3.4.1	8.72	8.72	2.20		19.19		19.19		19.19	250	235	0.0040	0.87	0.038	10.53	5.00	6.88	2.75	3.65	2.25	
BRS-3.4.2	42.67	51.40	1.70		87.37		87.37		87.37	630	582	0.0017	1.04	0.276	5.00	6.30	2.37	1.43	2.63	4.87	
BRS-5.1	13.25	13.25	2.04		27.04		27.04		27.04	400	377	0.0020	0.84	0.094	9.70	7.30	4.16	2.90	5.54	4.40	PJ(900)
Total	1,100.48																				

Remaks: MP: Manhole Pump, PJ(900): Pipe Jacking Method(Diameter: 900mm)

Year 2020 (Priority Area)

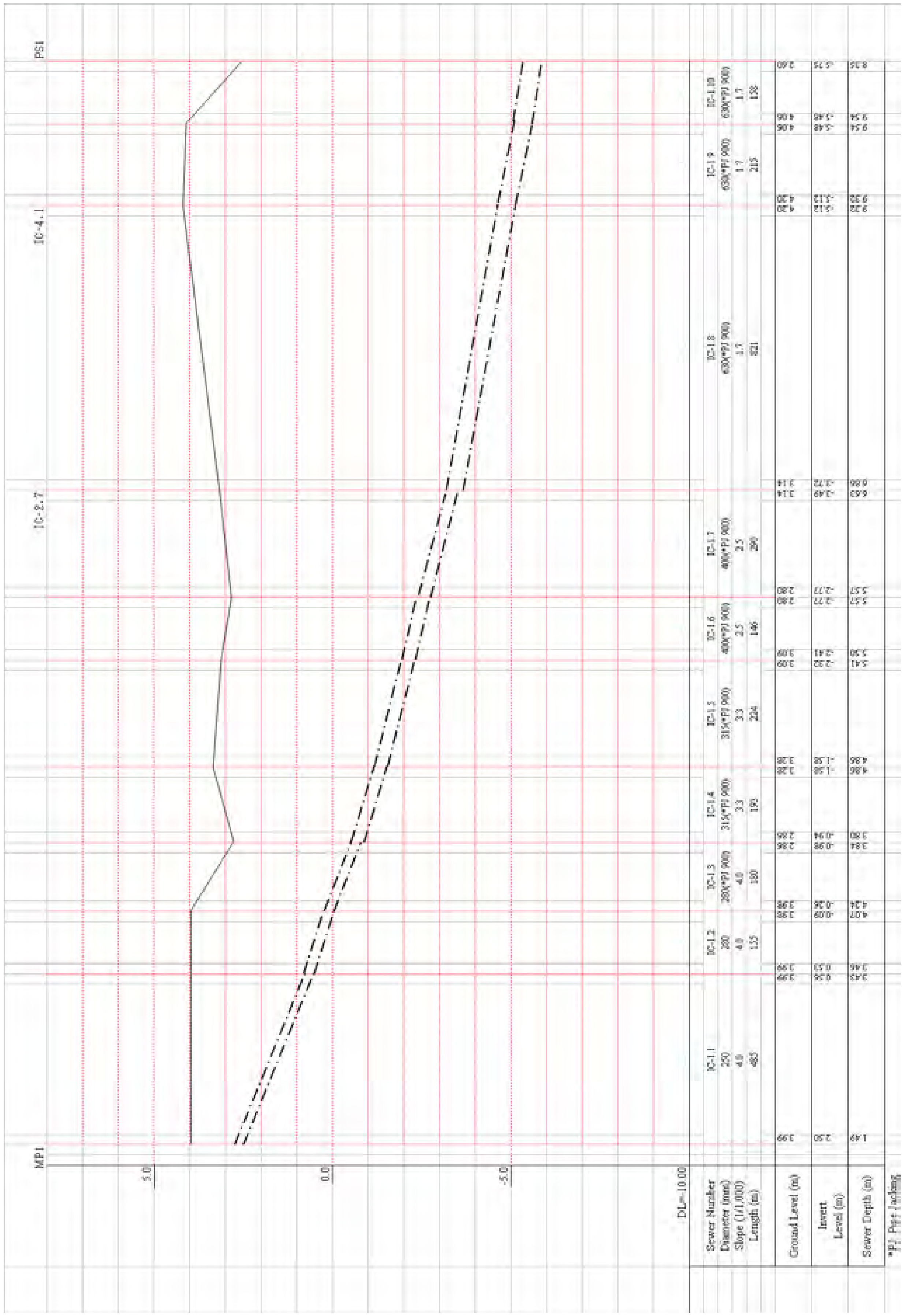
Section		MainSewers	Length	Size of Catchment Area								Total Area	Population Density & Population								Total population	Wastewater Flow									Capacity of Pipe					Ground level		Invert level		Sewer depth		Remarks
Start point	End Point			1.1	1.2	1.3	2	3.1	3.2	4.1	5		1.1	1.2	1.3	2	3.1	3.2	4.1	5		Unit Flow/Q ave	Accumulated Qave	Peak factor	Combined K	Peak flow	Flow from upstream	Q total	Pump point	Q grand Total	DN	Di	Slope	Velocity	Quantity	Begin	End	Begin	End	Begin	End	
			(m)	(ha)								(ha)	(persons/ha, persons)								(persons)	l/cap/s, l/s				l/s	l/s	l/s			mm			m/s	m^3/s	(m)	(m)	(m)	(m)	(m)	(m)	
Combined System													233									0.001829																				
Separate System														233	137	179	143	143	100	62.7		0.001979																				
11.1	11.2	IC-1.1	485	36.02								36.02	8,378								8,378	15.32		2.00	2.00	30.65		30.65		30.65	250	231	0.0040	0.86	0.036	3.99	3.99	2.50	0.56	1.49	3.43	MP
11.2	11.3	IC-1.2	155	6.96								6.96	1,620								1,620	2.96		2.50	2.00	7.41	30.65	38.06		38.06	280	259	0.0040	0.93	0.049	3.99	3.98	0.53	-0.09	3.46	4.07	
11.3	11.4	IC-1.3	180	4.30								4.30	999								999	1.83		2.50	2.00	4.57	38.06	42.63		42.63	280	259	0.0040	0.93	0.049	3.98	2.86	-0.26	-0.98	4.24	3.84	PJ(900)
11.4	11.5	IC-1.4	193	12.72								12.72	2,959								2,959	5.41		2.50	2.00	13.53	42.63	56.16		56.16	315	291	0.0033	0.91	0.061	2.86	3.28	-0.94	-1.58	3.80	4.86	PJ(900)
11.5	11.6	IC-1.5	224	3.05								3.05	710								710	1.30		2.50	2.00	3.25	56.16	59.41		59.41	315	291	0.0033	0.91	0.061	3.28	3.09	-1.58	-2.32	4.86	5.41	PJ(900)
11.6	11.7	IC-1.6	146	29.27								29.27	6,809								6,809	12.45		2.05	2.00	25.53	59.41	84.94		84.94	400	369	0.0025	0.93	0.099	3.09	2.80	-2.41	-2.77	5.50	5.57	PJ(900)
11.7	11.8	IC-1.7	290	2.76								2.76	641								641	1.17		2.50	2.00	2.93	84.94	87.87		87.87	400	369	0.0025	0.93	0.099	2.80	3.14	-2.77	-3.49	5.57	6.63	PJ(900)
11.8	11.9	IC-1.8	821	32.26								32.26	7,505								7,505	13.73		2.02	2.00	27.73	205.30	233.03		233.03	630	582	0.0017	1.04	0.276	3.14	4.20	-3.72	-5.12	6.86	9.32	PJ(900)
11.9	11.10	IC-1.9	215	6.66								6.66	1,548								1,548	2.83		2.50	2.00	7.08	233.03	240.11		240.11	630	582	0.0017	1.04	0.276	4.20	4.06	-5.12	-5.48	9.32	9.54	PJ(900)
11.10	PS-1	IC-1.10	158	11.55								11.55	2,687								2,687	4.91		2.50	2.00	12.28	243.73	256.01		256.01	630	582	0.0017	1.04	0.276	4.06	2.60	-5.48	-5.75	9.54	8.35	PJ(900)
12.00	12.10	IC-2.0	447	32.18								32.18	7,485								7,485	13.69		2.02	2.00	27.65		27.65		27.65	150	208	-0.0025	-	-	2.40	3.50	1.25	2.35	1.15	1.15	MP
12.1	12.2	IC-2.1	572	13.32								13.32	3,098								3,098	5.67		2.50	2.00	14.16	27.65	41.81		41.81	200	-	0.0012	-	-	3.50	2.89	2.30	1.69	1.20	1.20	MP
12.2	12.3	IC-2.2	371	14.64								14.64	3,404								3,404	6.23		2.40	2.00	14.94	41.81	56.75		56.75	315	291	0.0033	0.91	0.061	2.89	2.32	1.40	0.13	1.49	2.19	
12.3	12.6	IC-2.3	134	6.29								6.29	1,463								1,463	2.68		2.50	2.00	6.69	56.75	63.44		63.44	355	328	0.0030	0.94	0.079	2.32	2.32	-0.04	-0.40	2.36	2.72	
12.6	12.7	IC-2.6	553	0.00								0.00									0	0.00			2.00	0.00	95.96	95.96		95.96	450	416	0.0022	0.94	0.128	2.32	2.18	-1.82	-3.04	4.14	5.22	
12.7	11.10	IC-2.7	370	0.00								0.00									0	0.00			2.00	0.00	117.43	117.43		117.43	450	416	0.0022	0.94	0.128	2.18	4.20	0.73	0.07	1.45	4.13	MP
12.4	12.6	IC-2.4	140	17.78								17.78	4,135								4,135	7.56		2.30	2.00	17.39		17.39		17.39	200	185	0.0050	0.83	0.022	2.57	2.32	0.28	0.42	2.29	1.90	
12.5	12.6	IC-2.5	153	14.81								14.81	3,446								3,446	6.30		2.40	2.00	15.13		15.13		15.13	200	185	0.0050	0.83	0.022	2.40	2.32	1.20	0.44	1.20	1.88	MP
12.7	12.8	IC-3.1	338	24.03								24.03	5,590								5,590	10.22		2.10	2.00	21.47		21.47		21.47	150	-	-0.0060	-	-	2.17	2.18	1.00	1.23	1.17	0.95	MP
13.1	11.10	IC-4.1	402	3.41								3.41	793								793	1.45		2.50	2.00	3.62	0.00	3.62		3.62	100	-	-0.0025	-	-	3.19	4.20	2.09	3.10	1.10	1.10	MP
	PS-1	BRS-1.1	0				43.18					43.18				7,722					7,722	15.28	15.28	2.00		30.56		30.56														
PS-1	TOTAL											0.00															256.01	256.01	286.57													
PS-1	21.1	MTS-1.1	1214				28.50					28.50				5,097					5,097	10.09	10.09	2.10		21.18		21.18	286.57	307.75	1200	1059	0.0010	1.19	1.044	2.60	2.10	-0.60	-3.82	3.20	5.92	
21.1	21.2	MTS-1.2	752				47.71					47.71				8,532					8,532	16.88	85.79	1.64		140.70		140.70	286.57	427.27	1200	1059	0.0010	1.19	1.044	2.10	2.10	-3.82	-4.57	6.04	6.79	PJ
21.2	21.3	MTS-1.3	362									0.00											138.44	1.59		220.13		220.13	286.57	506.70	1500	1500	0.0010	1.26	2.235	2.10	2.10	-4.87	-5.23	7.09	7.45	PJ
21.3	21.4	MTS-1.4	475				5.17					5.17				925					925	1.83	187.28	1.58		295.89		295.89	286.57	582.46	1500	1500	0.0010	1.26	2.235	2.10	2.10	-5.23	-5.71	7.45	7.93	PJ
21.4	21.5	MTS-1.5	605				34.23					34.23				6,121					6,121	12.11	199.39	1.58		315.03		315.03	286.57	601.60	1500	1500	0.0010	1.26	2.235	2.10	2.10	-5.71	-6.32	7.93	8.54	PJ
21.5	STP2	MTS-1.6	20																				232.10	1.57		364.40		364.40	286.57	650.97	1500	1500	0.0010	1.26	2.235	2.10	2.10	-6.32	-6.34	8.54	8.56	PJ

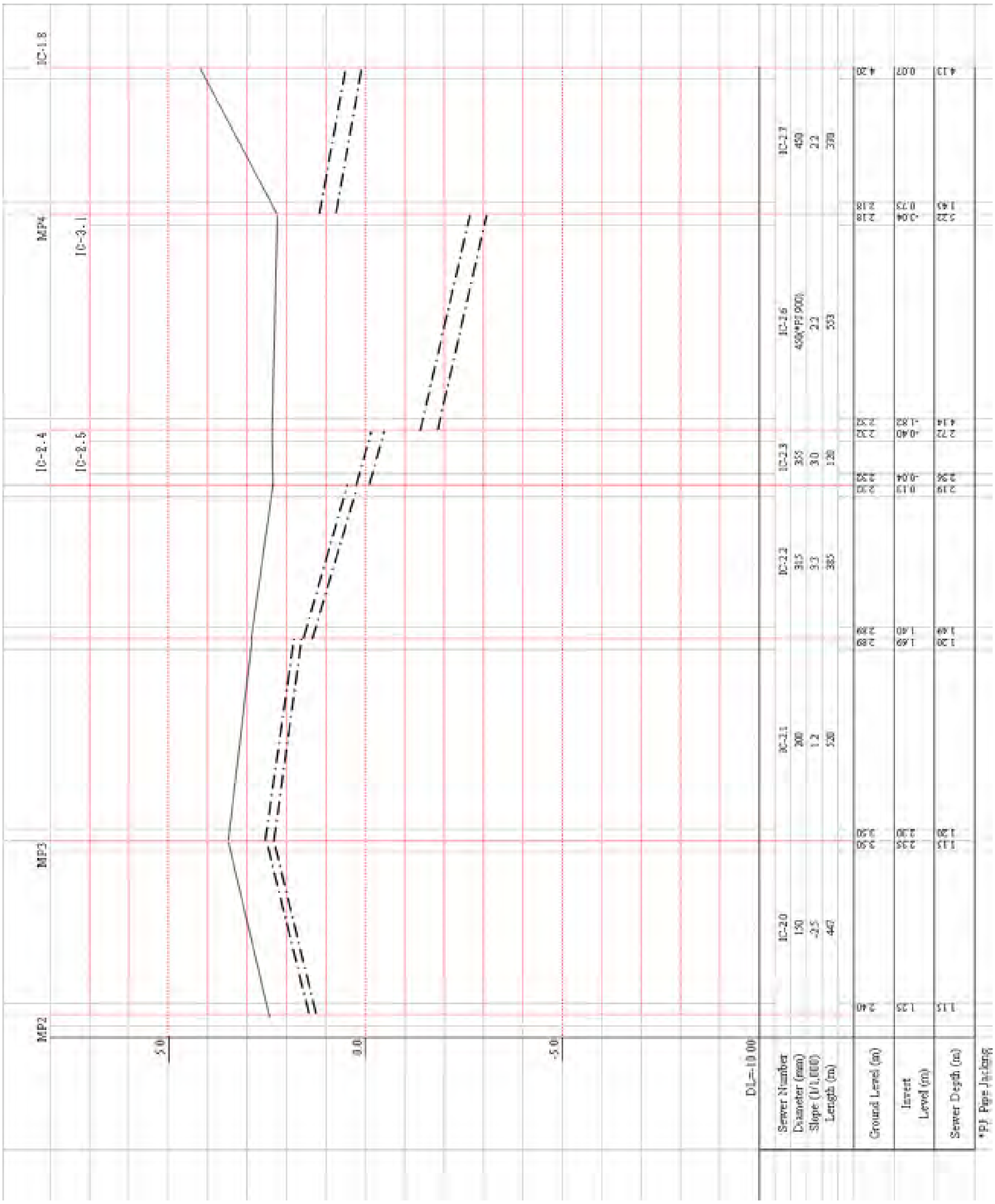
Peak Flow at STP2 Route 56,244 (m^3/day) (round: 56,200 m^3/day)

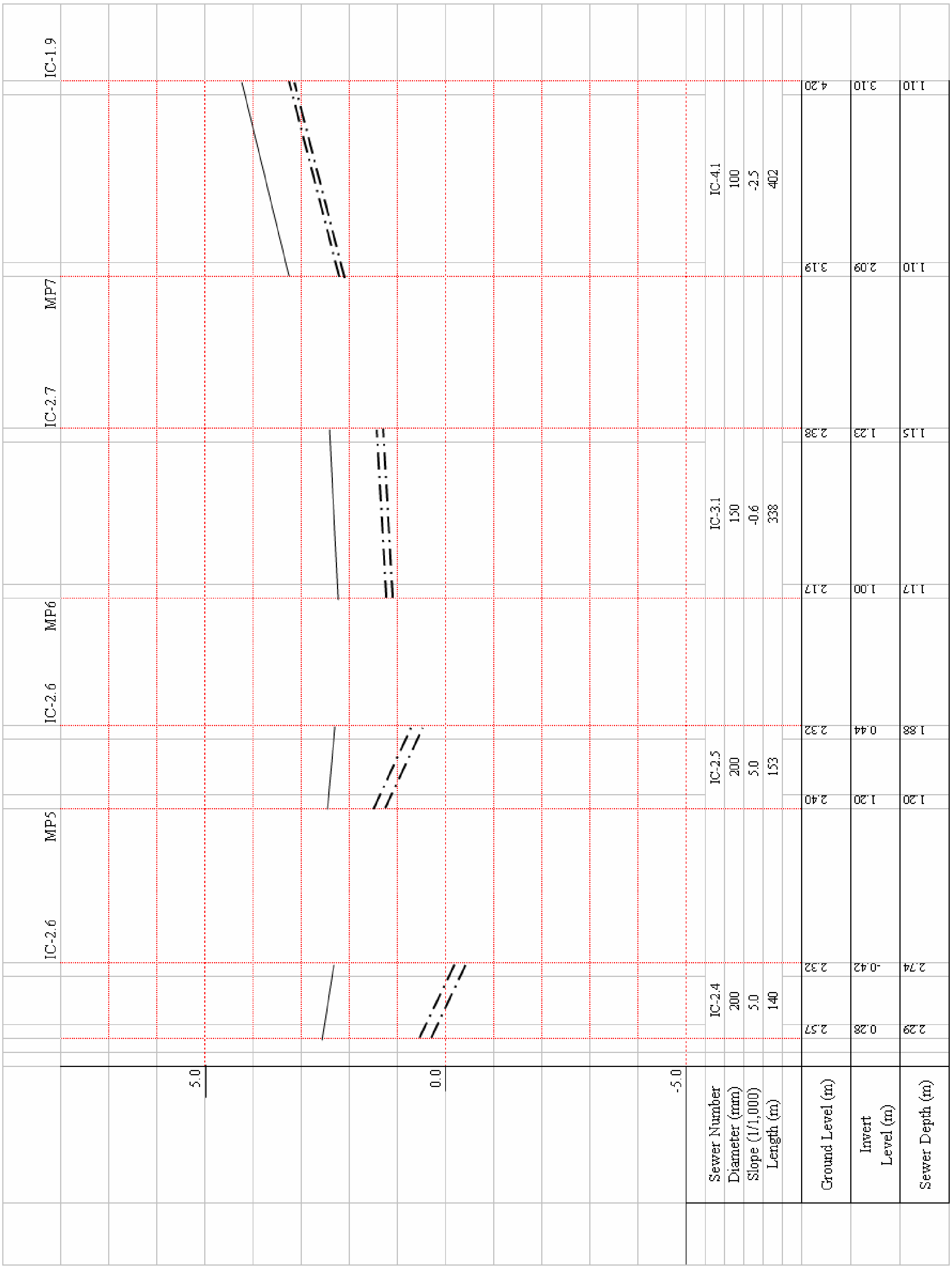
Remaks: MP: Manhole Pump, PJ(900): Pipe Jacking Method(Diameter: 900mm)

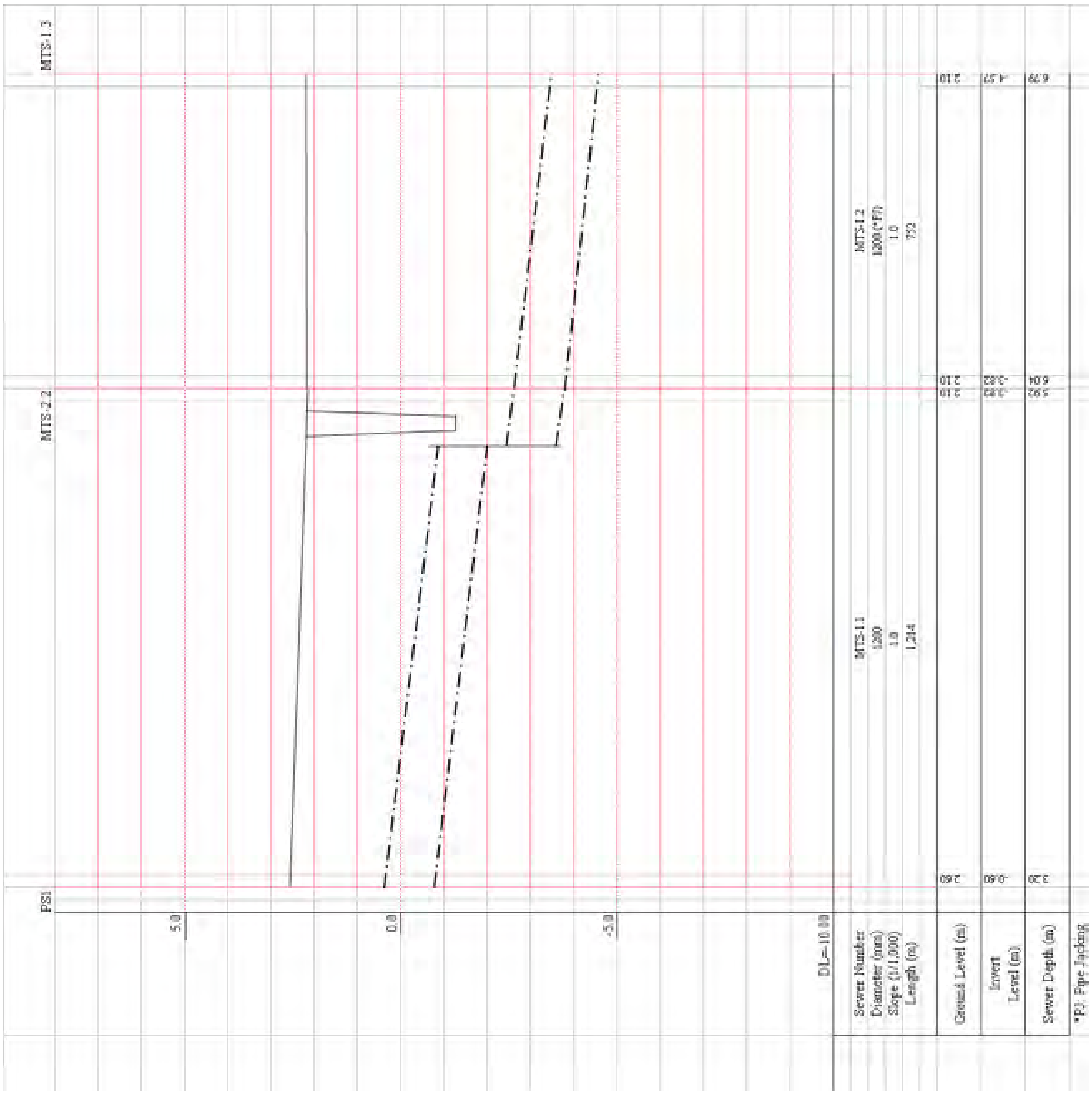
Appendix 5-C

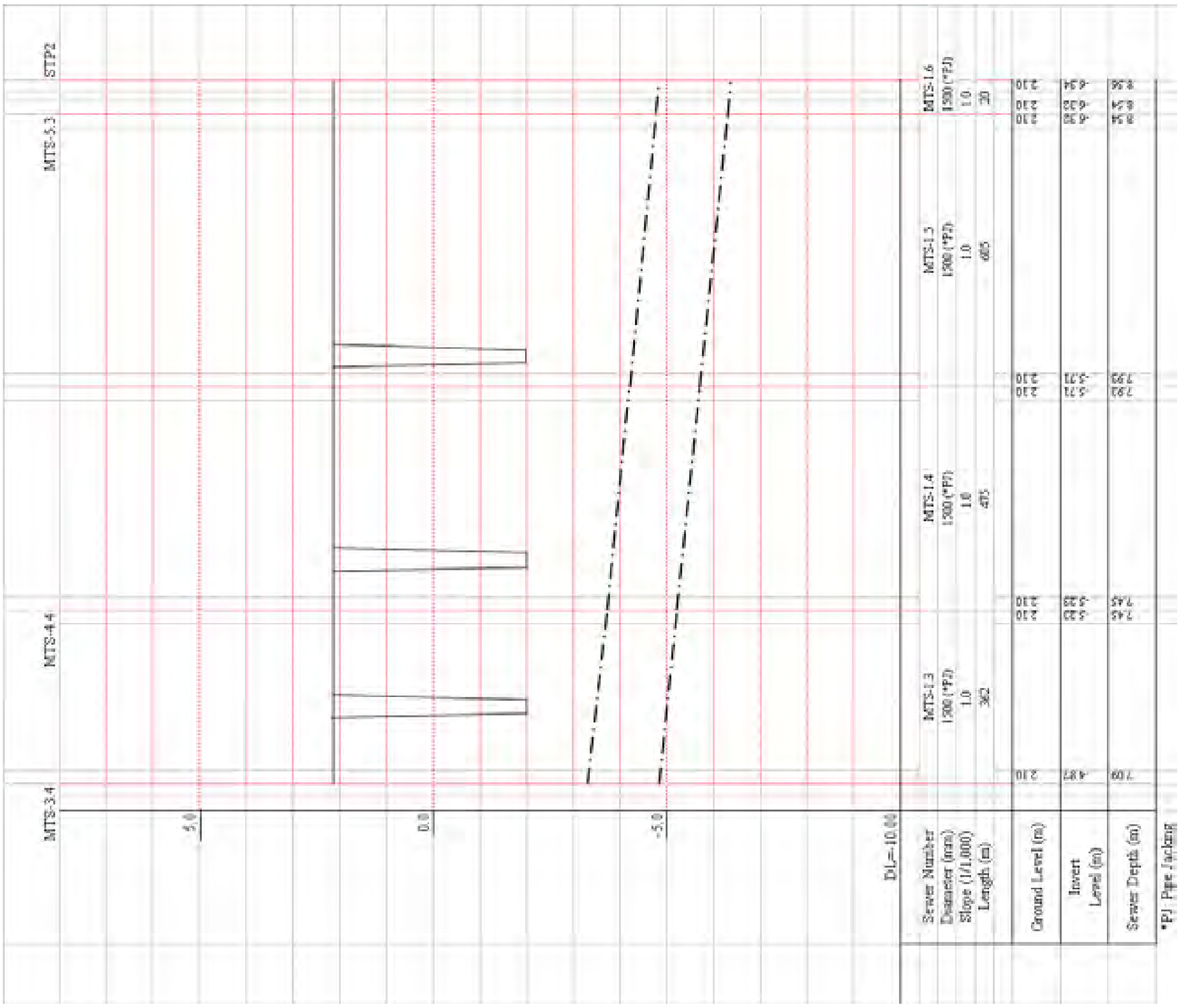
Longitudinal Section of Sanitary Sewer

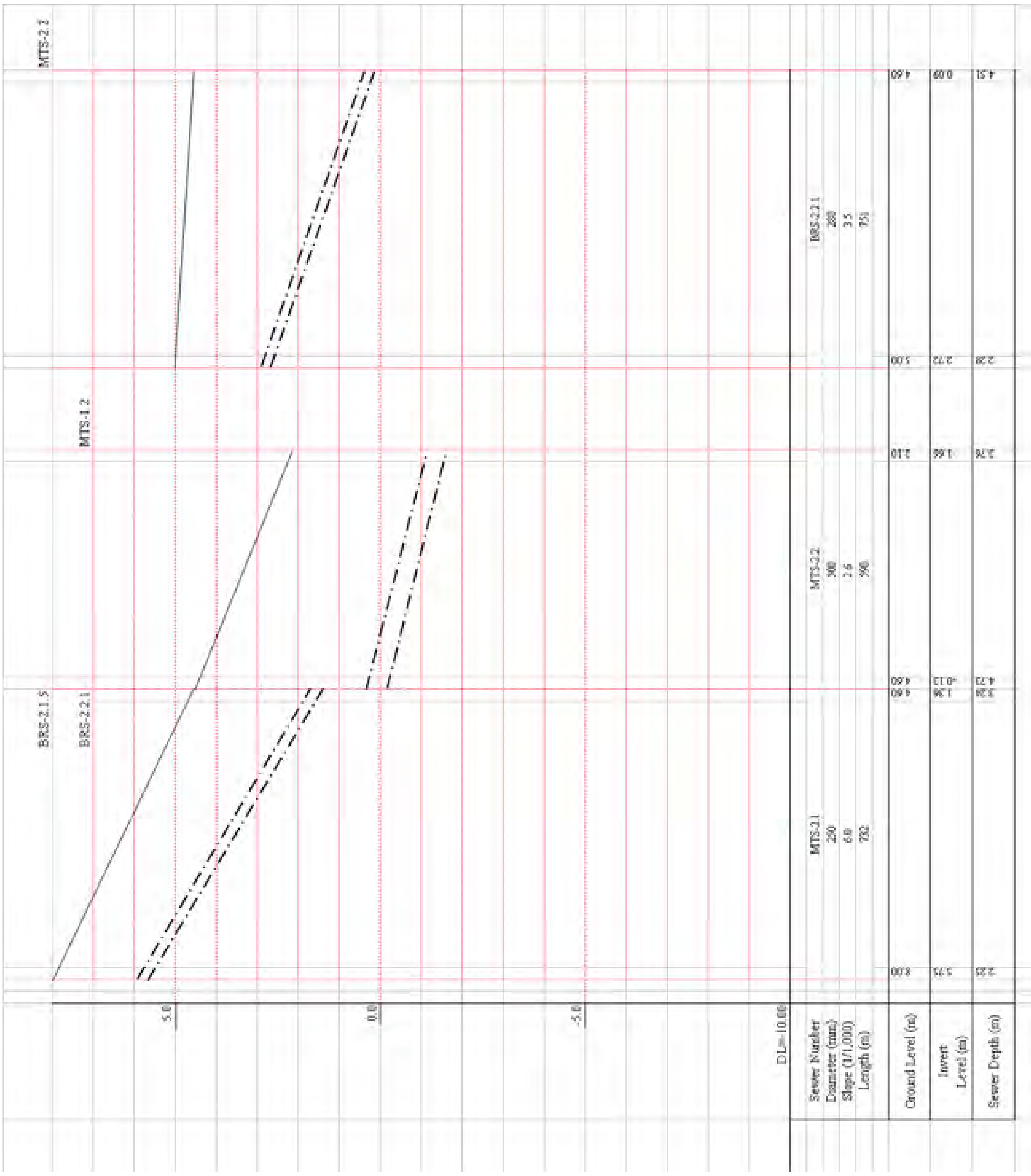

PS1
IC-4.1
IC-2.7
MP1
5.0
0.0
-5.0
DL=-10.00
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)
*PJ: Pipe Jacking

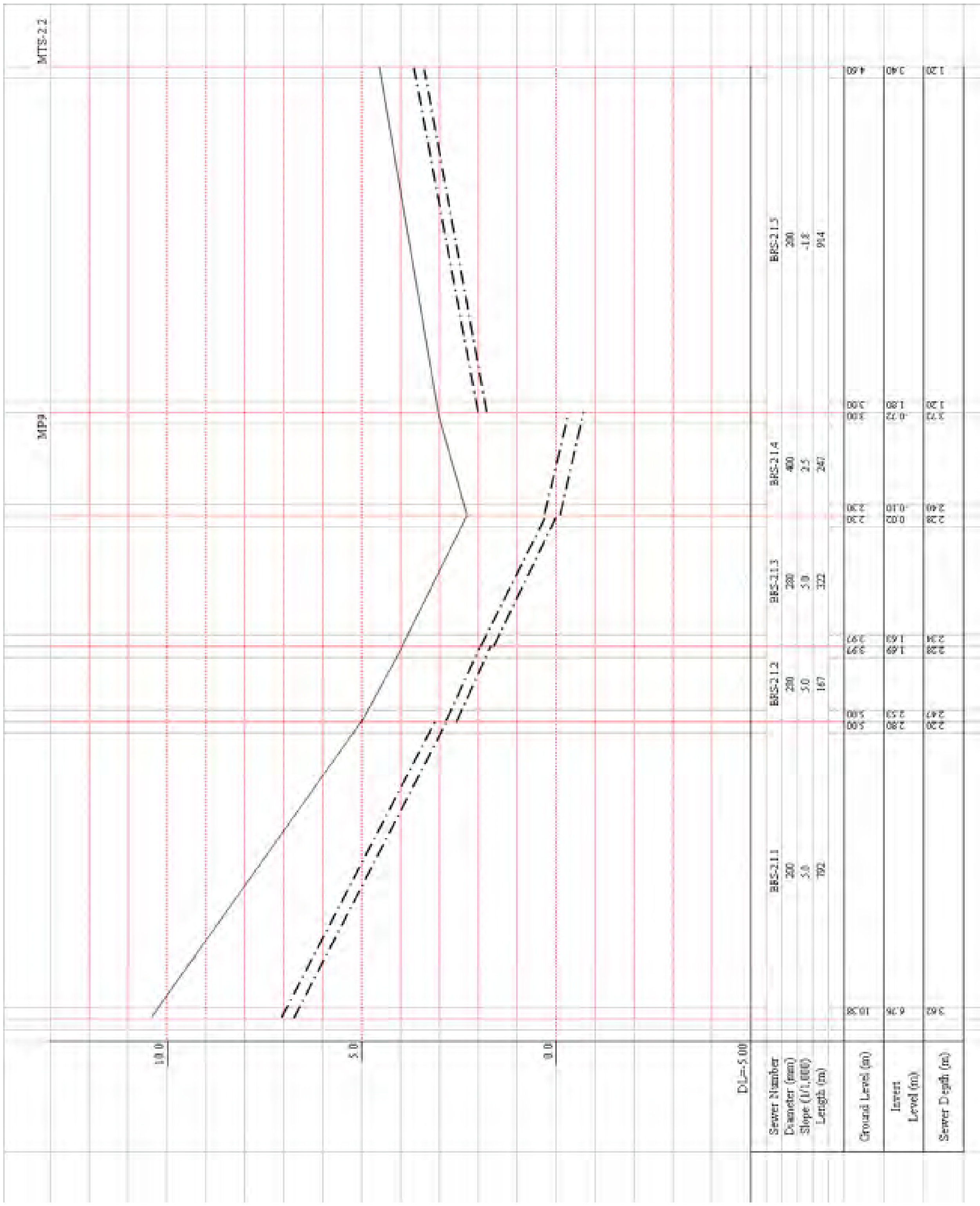

MP2
MP3
MP4
IC-1.8
IC-2.4
IC-2.5
IC-3.1
DL=-10.00
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)
*PJ: Pipe Jacking

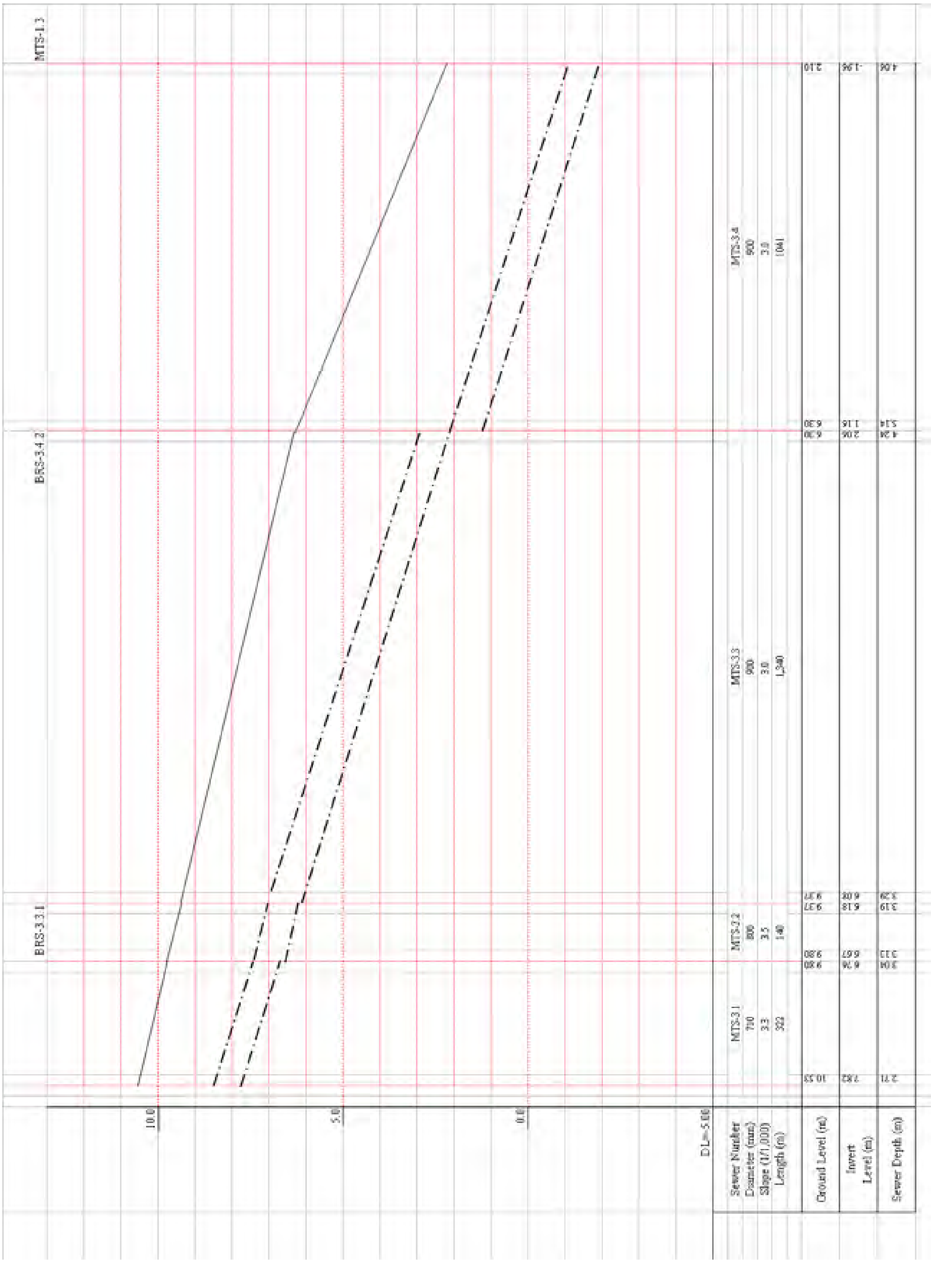

IC-1.9
MP7
IC-2.7
MP6
IC-2.6
MP5
IC-2.6
IC-4.1
100
-2.5
402
IC-3.1
150
-0.6
338
IC-2.5
200
5.0
153
IC-2.4
200
5.0
140
4.20
3.10
1.10
3.19
2.09
1.10
2.38
1.23
1.15
2.17
1.00
1.17
2.32
0.44
1.88
2.40
1.20
1.20
2.32
-0.42
2.74
2.57
0.28
2.29
5.0
0.0
-5.0
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)

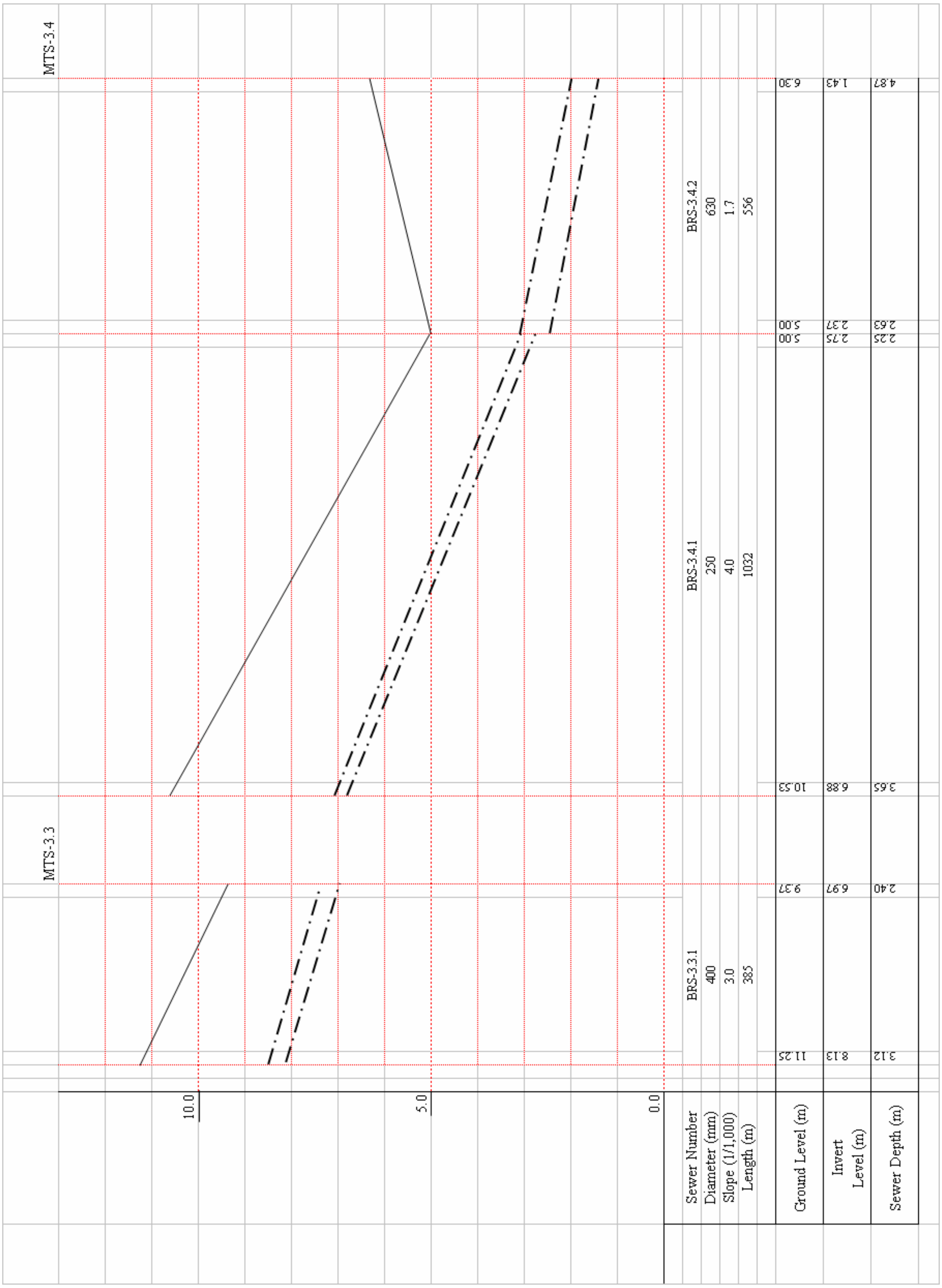

MTS-1.3
MTS-2.2
PS1
MTS-1.2
1200 (*PJ)
1.0
752
MTS-1.1
1200
1.0
1,314
5.0
0.0
-5.0
DL=-10.00
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)
*PJ: Pipe Jacking

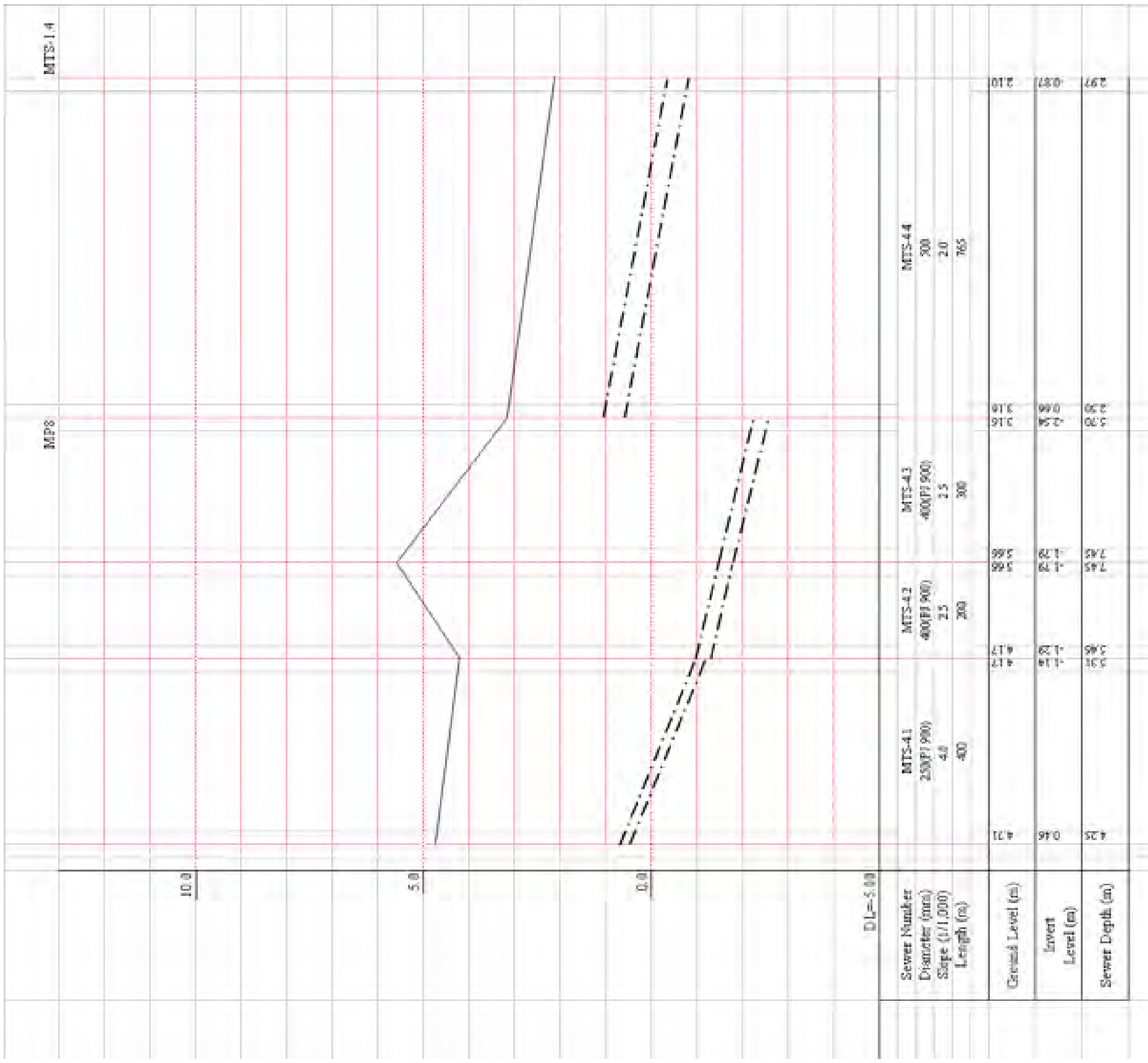

STP2
MTS-5.3
MTS-4.4
MTS-3.4
5.0
0.0
-5.0
DL=-10.00
MTS-1.6
MTS-1.5
MTS-1.4
MTS-1.3
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)
*PJ: Pipe Jacking

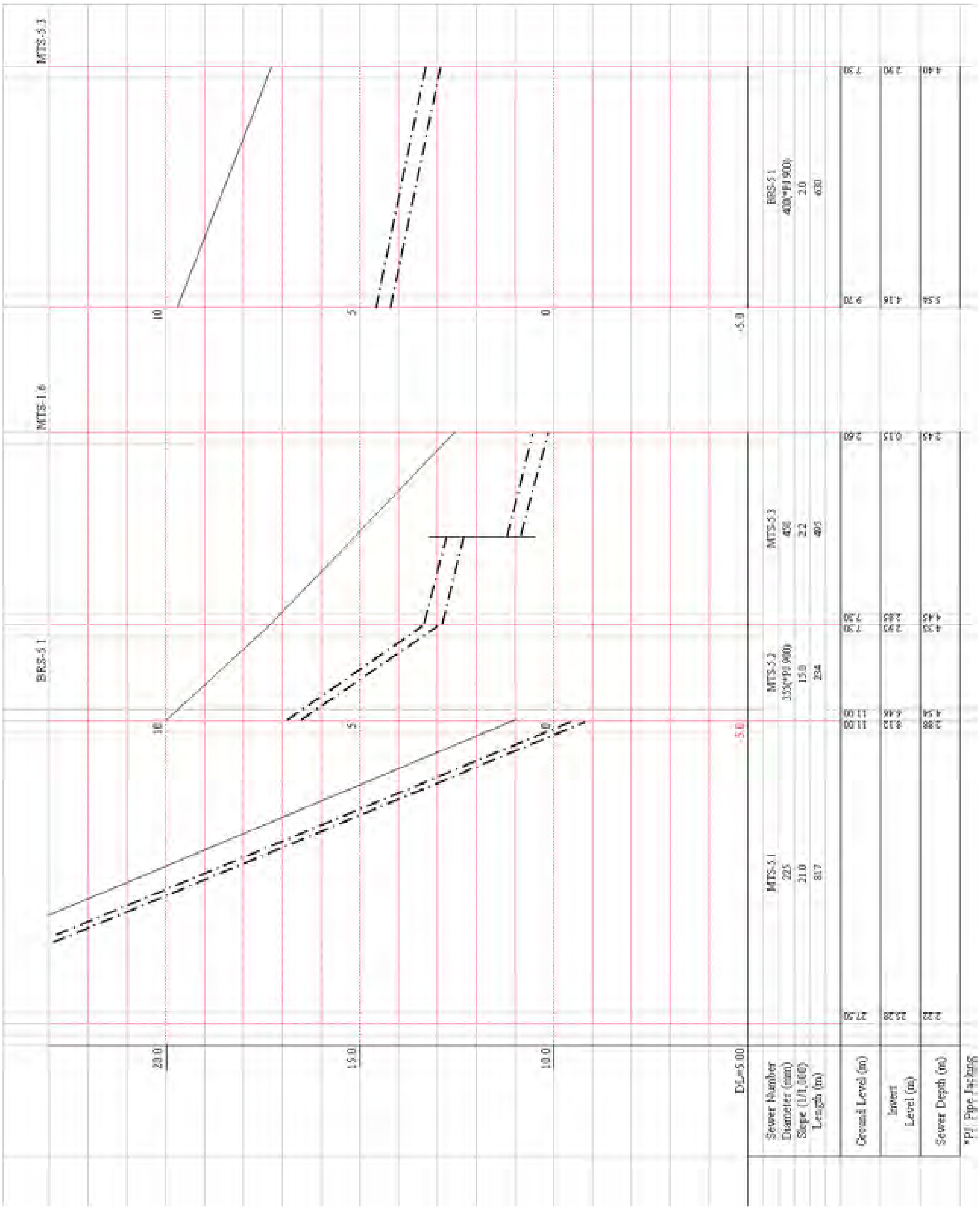

MTS-2.2
MTS-1.2
BRS-2.1.5
BRS-2.2.1
BRS-2.2.1
MTS-2.2
MTS-2.1
5.0
0.0
-5.0
DL=-10.00
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)


MTS-2.2
MP9
BRS-21.5
200
-1.8
984
BRS-21.4
400
2.5
247
BRS-21.3
200
5.0
322
BRS-21.2
200
5.0
167
BRS-21.1
200
5.0
792
10.0
5.0
0.0
DL=-5.00
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)


MTS-1.3
BRS-3.4.2
BRS-3.3.1
MTS-3.4
900
3.0
1,041
MTS-3.3
900
3.0
1,340
MTS-3.2
800
3.5
140
MTS-3.1
700
3.3
322
10.0
5.0
0.0
DL=-5.00
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)


MTS-3.4
MTS-3.3
BRS-3.4.2
630
1.7
556
BRS-3.4.1
250
4.0
1032
BRS-3.3.1
400
3.0
385
10.0
5.0
0.0
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)
6.30
1.43
4.87
5.00
2.37
2.63
5.00
2.75
2.25
10.53
6.88
3.65
9.37
6.97
2.40
11.25
8.13
3.12


MP8
MTS-44
MTS-43
MTS-42
MTS-41
10.0
5.0
0.0
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)


MTS-5.3
MTS-1.6
BRS-5.1
BRS-5.1
MTS-5.3
MTS-5.2
MTS-5.1
225
21.0
817
DL=5.00
Sewer Number
Diameter (mm)
Slope (1/1,000)
Length (m)
Ground Level (m)
Invert Level (m)
Sewer Depth (m)
*PJ: Pipe Jacking

Appendix 5-D

Detail Information of Overflow Chamber

Appendix 5-D Detail Information of Overflow Chamber

No.	Overflow Chamber No.	IC No.	Total Flow (m^3/sec)	Peak Sewage Flow (m^3/sec)	Discharge Flow (m^3/sec)	Sewer Type	Sewer Size of Outlet (m)	Inlet Invert Level (m)	Outlet Invert Level (m)	Discharge Basin
1	3119	1.1	7.682	0.028	7.654	box culvert	3.0×2.5	-0.63	-0.63	Dong Nai river
2	3120	1.2	0.713	0.003	0.711	pipe	0.6	2.21	2.21	Dong Nai river
3	3121	1.2	0.461	0.002	0.459	pipe	0.6	1.99	1.99	Dong Nai river
4	3122	1.3	0.634	0.002	0.631	pipe	0.6	0.75	0.75	Dong Nai river
5	3123	1.3	0.456	0.002	0.454	pipe	0.6	0.97	0.97	Dong Nai river
6	3124-O	1.4	2.752	0.011	2.740	pipe	1.2	0.57	0.37	Dong Nai river
7	3128	1.5	0.660	0.002	0.658	pipe	0.6	1.01	1.01	Dong Nai river
8	3129	1.5	0.413	0.002	0.411	pipe	0.6	1.01	1.01	Dong Nai river
9	3126-O	1.6	5.949	0.022	5.927	pipe	2.0	-0.33	-0.33	Dong Nai river
10	3130	1.7	0.819	0.003	0.816	pipe	1.0	0.62	0.62	Dong Nai river
11	3132	1.8	1.570	0.006	1.564	pipe	1.2	1.29	1.29	Dong Nai river
12	3133	1.9	1.769	0.007	1.762	pipe	1.5	2.57	2.57	Dong Nai river
13	3135-O	4.1	1.753	0.007	1.746	pipe	1.2	0.79	0.59	Stream
14	3137-O	2.6	6.094	0.022	6.072	box culvert	2.0×2.0	-0.29	-0.29	Stream
15	3139-O	1.5	1.919	0.008	1.911	pipe	1.5	0.41	0.11	Stream
16	3140	2.5	2.519	0.010	2.509	pipe	1.8	-0.29	-0.29	Stream
17	3141	2.4	2.059	0.008	2.051	pipe	1.0	0.78	0.78	Stream
18	3142	2.4	1.383	0.005	1.377	pipe	0.8	0.82	0.82	Stream
19	3143	2.3	2.462	0.010	2.452	pipe	1.8	0.46	0.46	Bien Hung Lake
20	3146	2.0	8.415	0.015	8.401	box culvert	2.0×2.0	-0.56	-0.56	Stream
21	3145	2.2	1.629	0.006	1.623	pipe	1.0	1.90	1.90	Bien Hung Lake
22	3147	2.1	3.075	0.012	3.063	pipe	1.5	1.38	1.38	Stream

Note 1; No. 3120 and 3133 overflow chambers are not installed flap gate because the outlet levels are higher than highest water level of Dong Nai river in Bien Hoa

Note 2; Average Diameter of Outlet is 1.5 m, Average Invert Level of Diversion Chamber is 2.0 m

Appendix 5-E

Hydraulic Calculation Sheet of STP2

1. Basic Conditions

（1） Name of STP　Bien Hoa Sewage treatment Plant
（2） Wastewater Treatment Process　Conventional Activated Sludge
（3） Design Flowrate

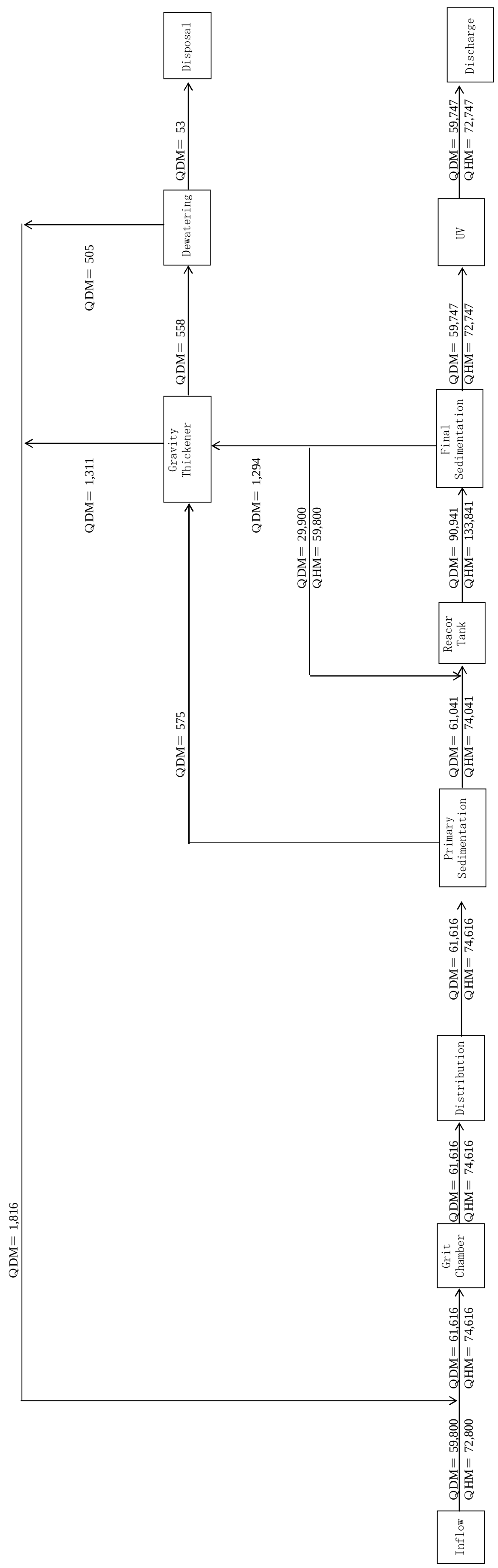
Design Flowrate	m^3／d	m^3／s
Average Daily Flowrate	52,000	0.602
Maximum Daily Flowrate	59,800	0.692
Maximum Hourly Flowrate	72,800	0.843

（4） Inflow Pipe
Pipe Diameter　φ600mm

（5） Discharge
River　Mahaweli River
Design High Water Level　+2.19 M
Design Average Water Level　+1.59 M

（6） Planned Ground Level
Existing Ground Level　+0.50 M ～ +2.50 M
Planned Ground Level　+3.61 M

2. Water Mass Balance



3. Hydraulic Calculation

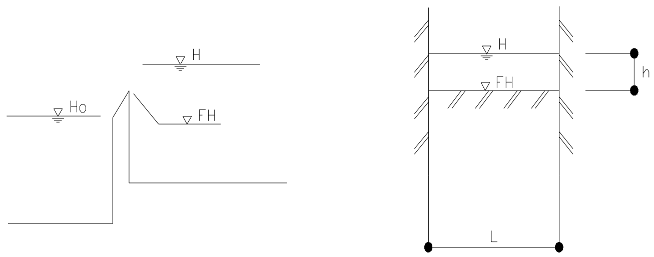
Point ［Discharge Pipe］ ※Gravity flow

Formula:Manning

Content		Symbol	Case		
			ＱDM	ＱHM	
Flowrate	(m^3/d)	Q	59,747	72,747	
	(m^3/s)		0.692	0.842	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.692	0.842	
Schematic Diagram			φ1200		
Length	(m)	L	60	n=0.013	
Number of 90°Bend		Nb	2		
Number of Manholes		Nm	2		
Diameter	(m)	D	1.200	1.200	
Cross Section	(m^2)	A	1.131	1.131	$\pi/4*D^2$
Wetted Perimeter	(m)	P	3.77	3.77	$\pi*D$
Hydraulic Radius	(m)	R	0.300	0.300	A/P
Velocity	(m/s)	V	0.612	0.744	q/A
Hydraulic Gradient	(‰)	I	0.315	0.466	$(n*V/R^{2/3})^2$
Lower point WL	(M)	Ho	+2.190	+2.190	
HEAD LOSS: Outlet	(m)		0.057	0.085	$1.0*(V^2/2g)*(Nm+1)$
Friction	(m)		0.019	0.028	I*L
90°Bend	(m)		0.038	0.056	$1.0*(V^2/2g)*Nb$
Entrance	(m)		0.029	0.042	$0.5*(V^2/2g)*(Nm+1)$
Total	(m)	h	0.143	0.211	
Water Level	(M)	H	+2.333	+2.401	Ho+h

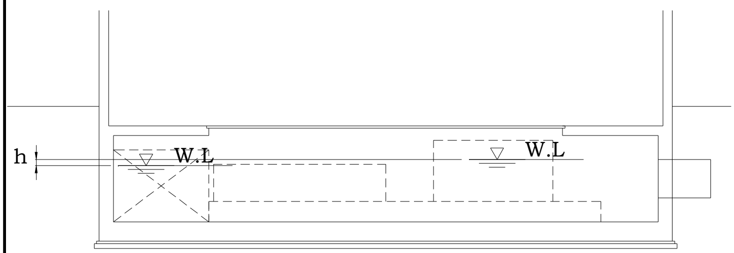
Point ［UV Disinfection］*Effluent Weir

Formula：Francis

Content		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	59,747	72,747	
	(m^3/s)		0.692	0.842	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.692	0.842	
Schematic Diagram					
Weir Width	(m)	L	3.00		
Weir Height	(M)	FH	+2.500		
Lower Water Level	(M)	Ho	+2.333	+2.401	
WATER DEPTH — Complete Overflow	(m)	h	0.25	0.285	(q/1.84*L)^(2/3)
Water Level	(M)	H	+2.750	+2.785	FH+h
UV Base Level			+1.000		

Point ［UV Disinfection ］*Machine Loss

Formula：

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	59,747	72,747	
	(m^3/s)		0.692	0.842	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.692	0.842	
Schematic Diagram			 UV machine is set weir plate at the downstream for controlling water level. The weir length is decided for the maximum change of water level is less than 60mm.		
Weir Height	(M)	FH	+3.000		
Lower Water Level	(M)	Ho	+2.750	+2.785	
HEAD LOSS: Complete Overflow	(m)	h	0.04	0.06	Include channel
Water Level	(M)	H	+3.040	+3.060	FH+h
UV Base Level			+1.500		

Point ［UV Disinfection～Final Sedimentation Tank -pipe1］

Formula：Darcy

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	59,747	72,747	
	(m^3/s)		0.692	0.842	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.692	0.842	
Schematic Diagram			φ1200		
Length	(m)	L	10.0		
Diameter	(m)	D	1.200	1.200	
Cross Section	(m^2)	A	1.131	1.131	$\pi/4*D^2$
Velocity	(m^3/s)	V	0.612	0.744	q/A
Friction coefficient		f	0.020	0.020	0.02+1/2000*D
Lower point WL	(M)	Ho	+3.040	+3.060	
HEAD LOSS Outlet	(m)		0.019	0.028	$1.0*(V^2/2g)*1$
HEAD LOSS Friction	(m)		0.003	0.005	$f*L/D*(V^2/2g)$
HEAD LOSS Entrance	(m)		0.010	0.014	$0.5*(V^2/2g)*1$
HEAD LOSS Total	(m)	h	0.032	0.047	
Water Level	(M)	H	+3.072	+3.107	Ho+h

Point ［Final Sedimentation Tank pipe1～pipe2］

Formula：Darcy

Contents		Symbol	Case		
			ＱDM	ＱHM	
Flowrate	(m^3/d)	Q	29,874	48,498	QDM=Q*1/2, QHM=Q*2/3
	(m^3/s)		0.346	0.561	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.346	0.561	
Schematic Diagram			φ900		
Length	(m)	L	16.0		
Diameter	(m)	D	0.900	0.900	
Cross Section	(m^2)	A	0.636	0.636	π/4*D^2
Velocity	(m^3/s)	V	0.544	0.882	q/A
Friction coefficient		f	0.021	0.021	0.02+1/2000*D
Lower point WL	(M)	Ho	+3.072	+3.107	
HEAD LOSS: Outlet	(m)		0.015	0.040	1.0*(V^2/2g)*1
HEAD LOSS: Friction	(m)		0.006	0.015	f*L/D*(V^2/2g)
HEAD LOSS: 90° Junction	(m)		0.03	0.079	1.0*(V^2/2g)*2
HEAD LOSS: Entrance	(m)		0.008	0.020	0.5*(V^2/2g)*1
HEAD LOSS: Total	(m)	h	0.059	0.154	
Water Level	(M)	H	+3.131	+3.261	Ho+h

Point ［Final Sedimentation Tank - Outlet Conduit 1］

Formula:Manning

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	29,874	48,498	QDM=Q*1/2, QHM=Q*2/3
	(m^3/s)		0.346	0.561	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.346	0.561	
Schematic Diagram					
Channel					
Width	(m)	B	0.900		
Base Level	(M)	FH	+2.400		
Length	(m)	L	24.00	n=0.013	
Water Depth	(m)	H'	0.731	0.861	Ho-FH
Cross Section	(m^2)	A	0.658	0.775	B*H'
Wetted Perimeter	(m)	P	2.362	2.622	2*H'+B
Hydraulic Radius	(m)	R	0.279	0.296	A/P
Velocity	(m^3/s)	V	0.526	0.724	p/A
Hydraulic Gradient	(‰)	I	0.256	0.449	$(n*V/R^{2/3})^2$
Lower point WL	(M)	Ho	+3.131	+3.261	
HEAD LOSS: Outlet	(m)		0.014	0.027	$1.0*(V^2/2g)*1$
HEAD LOSS: Friction	(m)		0.006	0.011	I*L
HEAD LOSS: Total	(m)	h	0.02	0.038	
Water Level	(M)	H	+3.151	+3.299	Ho+h

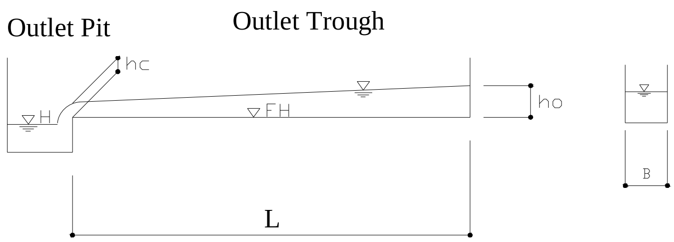
Point ［Final Sedimentation Tank - Outlet Conduit 2］

Formula:Manning

Contents		Symbol	Case		
			ＱDM	ＱHM	
Flowrate	(m^3/d)	Q	14,937	24,249	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.173	0.281	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.173	0.281	
Schematic Diagram					
Channel					
Width	(m)	B	0.900		
Base Level	(M)	FH	2.400		
Length	(m)	L	24.00	n=0.013	
Water Depth	(m)	H'	0.751	0.899	Ho-FH
Cross Section	(m^2)	A	0.676	0.809	B*H'
Wetted Perimeter	(m)	P	2.402	2.698	2*H'+B
Hydraulic Radius	(m)	R	0.281	0.300	A/P
Velocity	(m^3/s)	V	0.256	0.347	p/A
Hydraulic Gradient	(‰)	I	0.060	0.101	$(n*V/R^{2/3})^2$
Lower point WL	(M)	Ho	+3.151	+3.299	
HEAD LOSS					
Friction	(m)		0.001	0.002	I*L
Total	(m)	h	0.001	0.002	
Water Level	(M)	H	+3.152	+3.301	Ho+h

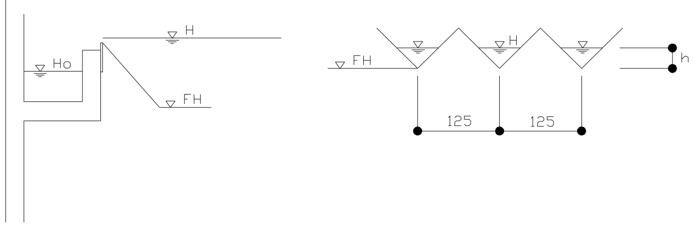
Point［Final Sedimentation Tank -Outlet Trough］

Formula：Thomas Gump

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	3,734	6,062	QDM=Q*1/16, QHM=Q*1/12
	(m^3/s)		0.043	0.07	
Number of pipes	(pipe)	n	2	2	
Flowrate/pipe	(m^3/s)	q	0.0215	0.035	
Schematic Diagram					
Length	(m)	L	8.000	m	
Width	(m)	B	0.300		
Base Level	(M)	FH	+3.400		
Critical depth	(m)	hc	0.081	0.112	$(q^2/9.8*B^2)^{1/3}$
Upper Water Level	(m)	ho	0.140	0.194	$\sqrt{3}$*hc
Lower Water Level	(M)	Ho	+3.152	+3.301	
HEAD LOSS					
Water Level	(M)	H	+3.540	+3.594	FH+ho

Point ［Final Sedimentation Tank］

Formula：Thompson

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	3,734	6,062	QDM=Q*1/16, QHM=Q*1/12
	(m^3/s)		0.043	0.07	
Number of pipes	(pipe)	n	128	128	
Flowrate/pipe	(m^3/s)	q	33.594 $\times 10^{-5}$	54.688 $\times 10^{-5}$	
Schematic Diagram			Outlet Trough Final Sedimentation Tank 		
Length	(m)	D	16.00	m (8.00 × 2)	
Number of Notch		n	128	(16m / 0.125m)	
Width	(m)	B	0.300		
Weir Height	(M)	FH	+3.650		
Lower Water Level	(M)	Ho	+3.540	+3.594	
WATER DEPTH Complete Overflow	(m)	h	0.035	0.043	(q/1.42)^(2/5)
Water Level	(M)	H	+3.685	+3.693	FH+h
Secondary Clarifier Base Level			-0.100		H-3.50

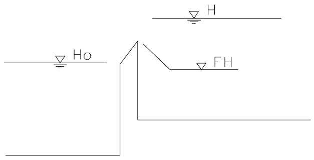
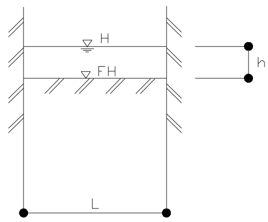
Point ［Final Sedimentation Tank ～ pipe］

Formula：Darcy

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	22,735	44,614	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.263	0.516	
Number of pipes	(pipe)	n	4	4	
Flowrate/pipe	(m^3/s)	q	0.066	0.129	
Schematic Diagram			φ400		
Length	(m)	L	6.00		
Diameter	(m)	D	0.400	0.400	
Cross Section	(m^2)	A	0.126	0.126	$\pi/4*D^2$
Velocity	(m^3/s)	V	0.522	1.024	q/A
Friction coefficient		f	0.021	0.021	0.02+1/2000*D
Lower Water Level	(M)	Ho	+3.685	+3.693	
HEAD LOSS: Entrance	(m)		0.007	0.027	$0.5*(V^2/2g)$
HEAD LOSS: Outlet	(m)		0.014	0.053	$1.0*(V^2/2g)$
HEAD LOSS: Friction	(m)		0.004	0.017	$f*L/D*(V^2/2g)$
HEAD LOSS: Total	(m)	h	0.025	0.097	
Water Level	(M)	H	+3.710	+3.790	FH+h

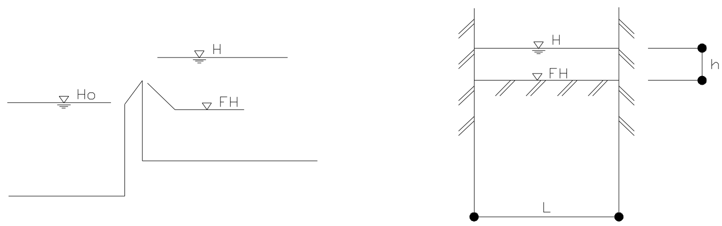
Point ［Reactor Tank Outlet ］

Formula：Francis

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	22,735	44,614	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.263	0.516	
Number of pipes	(pipe)	n	2	2	
Flowrate/pipe	(m^3/s)	q	0.132	0.258	
Schematic Diagram			 		
Weir Width	（m）	L	8.00		
Weir Height	(M)	FH	+3.900		
Lower Water Level	(M)	Ho	+3.710	+3.790	
WATER DEPTH — Complete Overflow	(m)	h	0.043	0.067	(q/1.84*L)^(2/3)
Water Level	(M)	H	+3.943	+3.967	FH+h
ＯＤ Base Level			-1.600		FH-5.500

Point ［Reactor Tank - Inlet］

Formula：Francis

Contents		Symbol	Case		
			ＱDM	ＱHM	
Flowrate	(m^3/d)	Q	15,260	24,680	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.177	0.286	
Number of pipes	(pipe)	n	2	2	
Flowrate/pipe	(m^3/s)	q	0.089	0.143	
Schematic Diagram					
Weir Width	（m）	L	0.50		
Weir Height	(M)	FH	+4.000		
Lower Water Level	(M)	Ho	+3.943	+3.967	
WATER DEPTH: Complete Overflow	(m)	h	0.21	0.289	(q/1.84*L)^(2/3)
Water Level	(M)	H	+4.210	+4.289	FH+h
Base Level			+4.000		

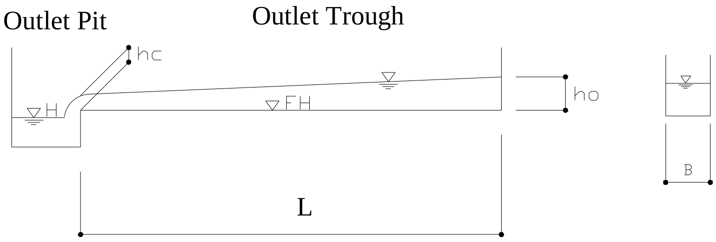
Point ［Primary Sedimentation Tank ~ Reactor Tank - Conduit ］

Formula:Manning

Contents		Symbol	Case		
			ＱDM	ＱHM	
Flowrate	(m^3/d)	Q	15,260	24,680	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.177	0.286	
Number of pipes	(pipe)	n	2	2	
Flowrate/pipe	(m^3/s)	q	0.089	0.143	
Schematic Diagram					
Channel					
Width	(m)	B	0.800		
Base Level	(M)	FH	+4.000		
Length	(m)	L	4.00	n=0.013	
Water Depth	(m)	H'	0.210	0.289	Ho-FH
Cross Section	(m^2)	A	0.168	0.231	B*H'
Wetted Perimeter	(m)	P	1.22	1.378	2*H'+B
Hydraulic Radius	(m)	R	0.138	0.168	A/P
Velocity	(m^3/s)	V	0.530	0.619	p/A
Hydraulic Gradient	(‰)	I	0.666	0.699	$(n*V/R^{2/3})^2$
Lower point WL	(M)	Ho	+4.210	+4.289	
HEAD LOSS Entrance	(m)		0.007	0.010	$0.5*(V^2/2g)$
HEAD LOSS Friction	(m)		0.003	0.003	I*L
HEAD LOSS Total	(m)	h	0.01	0.013	
Water Level	(M)	H	+4.220	+4.302	Ho+h

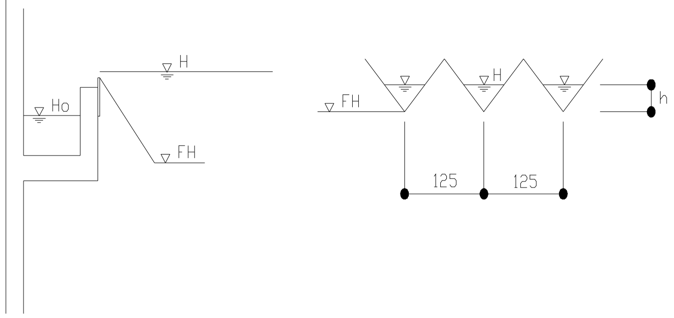
Point［Primary Sedimentation Tank -Outlet Trough］

Formula：Thomas Gump

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	3,815	6,170	QDM=Q*1/16, QHM=Q*1/12
	(m^3/s)		0.044	0.071	
Number of pipes	(pipe)	n	2	2	
Flowrate/pipe	(m^3/s)	q	0.022	0.0355	
Schematic Diagram					
Length	(m)	L	16.000	m	
Width	(m)	B	0.300		
Base Level	(M)	FH	+4.500		
Critical depth	(m)	hc	0.082	0.113	$(q^2/9.8*B^2)^{1/3}$
Upper Water Level	(m)	ho	0.142	0.196	$\sqrt{3}$*hc
Lower Water Level	(M)	Ho	+4.220	+4.302	
HEAD LOSS					
Water Level	(M)	H	+4.642	+4.696	FH+ho

Point ［Primary Sedimentation Tank］

Formula：Thompson

Contents		Symbol	Case QDM	Case QHM	Case
Flowrate	(m^3/d)	Q	3,815	6,170	QDM=Q*1/16, QHM=Q*1/12
	(m^3/s)		0.044	0.071	
Number of pipes	(pipe)	n	256	256	
Flowrate/pipe	(m^3/s)	q	17.188 $\times 10^{-5}$	27.734 $\times 10^{-5}$	
Schematic Diagram			Outlet Trough Primary Sedimentation Tank 		
Length	(m)	D	32.000	m (16.00 × 2)	
Number of Notch		n	256	(32m / 0.125m)	
Width	(m)	B	0.300		
Weir Height	(M)	FH	+4.750		
Lower Water Level	(M)	Ho	+4.642	+4.696	
WATER DEPTH: Complete Overflow	(m)	h	0.027	0.033	(q/1.42)^(2/5)
Water Level	(M)	H	+4.777	+4.783	FH+h
Secondary Clarifier Base Level			+1.200		H-3.50

Point ［Primary Sedimentation Tank - Inlet ］

Formula:Manning

Contents		Symbol	Case		
			ＱDM	ＱHM	
Flowrate	(m^3/d)	Q	15,404	24,872	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.178	0.288	
Number of pipes	(pipe)	n	4	4	
Flowrate/pipe	(m^3/s)	q	0.045	0.072	
Schematic Diagram					
Channel					
Width	(m)	B	0.500		
Base Level	(M)	FH	+4.400		
Water Depth	(m)	H'	0.377	0.383	
Cross Section	(m^2)	A	0.189	0.192	B*H'
Wetted Perimeter	(m)	P	1.254	1.266	2*H'+B
Hydraulic Radius	(m)	R	0.151	0.152	A/P
Velocity	(m^3/s)	V	0.238	0.375	p/A
Lower point WL	(M)	Ho	+4.777	+4.783	
HEAD LOSS — Entrance	(m)		0.001	0.004	0.5*(V^2/2g)
HEAD LOSS — Outlet	(m)		0.003	0.007	1.0*(V^2/2g)
HEAD LOSS — Total	(m)	h	0.004	0.011	
Water Level	(M)	H	+4.781	+4.794	Ho+h

Point ［Primary Sedimentation Tank ～ Distribution Tank］

Formula：Darcy

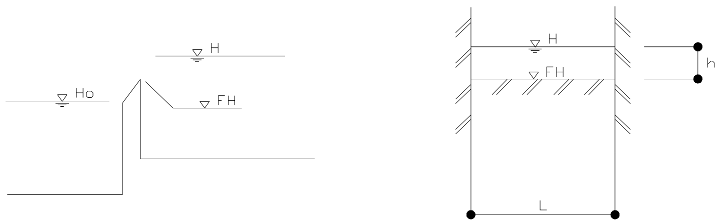
Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	15,404	24,872	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.178	0.288	
Number of pipes	(pipe)	n	1	1	
Flowrate/pipe	(m^3/s)	q	0.178	0.288	
Schematic Diagram			φ600		
Length	(m)	L	120.0		
Diameter	(m)	D	0.600	0.600	
Cross Section	(m^2)	A	0.283	0.283	$\pi/4*D^2$
Velocity	(m^3/s)	V	0.629	1.018	q/A
Friction coefficient		f	0.021	0.021	0.02+1/2000*D
Lower Water Level	(M)	Ho	+4.781	+4.794	
HEAD LOSS: Entrance	(m)		0.010	0.026	$0.5*(V^2/2g)$
Outlet	(m)		0.020	0.053	$1.0*(V^2/2g)$
Friction	(m)		0.085	0.222	$f*L/D*(V^2/2g)$
45°Bend	(m)		0.008	0.021	$0.13*(V^2/2g)*3$
Total	(m)	h	0.123	0.322	
Water Level	(M)	H	+4.904	+5.116	FH+h

Point ［Distribution Tank］

Formula：Francis

Contents		Symbol	Case		
			QDM	QHM	
Flowrate	(m^3/d)	Q	15,404	24,872	QDM=Q*1/4, QHM=Q*1/3
	(m^3/s)		0.178	0.288	
Number of pipes	(pipe)	n	2	2	
Flowrate/pipe	(m^3/s)	q	0.089	0.144	

Schematic Diagram



Weir Width	（m）	L	0.30		
Weir Height	(M)	FH	+5.400		
Lower Water Level	(M)	Ho	+4.904	+5.116	
WATER DEPTH: Complete Overflow	(m)	h	0.296	0.408	(q/1.84*L)^(2/3)
Water Level	(M)	H	+5.696	+5.808	FH+h

Appendix 5-F

The Consideration for Composting

Appendix 5-F COMPOSTING OF SLUDGE

1. Purpose

The activated sludge produced at the treatment plant will be dewatered and sent to the sanitary landfill for disposal. However, composting is also an attractive option because composted sludge can be reused as a soil conditioner for agriculture and horticulture . Recently Binh Hung STP in Ho Chi Minh City uses composting for sludge treatment. In this annex, the regulations pertaining to composting are reviewed and land area for a composting facility is calculated.

2. Regulations and Standards for Composting

There are three regulations that are applicable to sludge compositing in Vietnam.

(1) Heavy metals

Allowable limits for heavy metals presented in (Table A5-F-1) are specified in QCVN 03:2008/BTNMT (National technical regulation on the allowable limits of heavy metals in soils). .

Table A5-F-1 Allowable Limits for Heavy Metals (mg/kg)

Item	Agricultural Soil	Forestry Soil	Reside Land	Trade Soil	Industrial Soil
1. As (Arsenic)	12	12	12	12	12
2. Cd (Cadmium)	2	2	5	5	10
3. Cu (Cupper)	50	70	70	100	100
4. Pb (Lead)	70	100	120	200	300
5. Zn (Zinc)	200	200	200	200	200

Source: QCVN-03:2008/BTNMT

(2) Compost quality

Other is TCVN 7185:2002 (Microbial organic fertilizer). This regulation mentions the quality of the end product (Table A5-F-2) when sludge is used to produce fertilizer. Generally the amount of nitrogen and phosphorus in activated sludge from domestic wastewater treatment plants is sufficient for organic fertilizer but the potassium level in sludge is low. Therefore the sludge from STP is better to be mixed with materials that contain potassium such as cattle dung.

Table A5-F-2 Condition for Microbial Organic Fertilizer

Items	Unit	Value	Remarks
1. Mature Degree	-	Good	7.2
2. Grain Size	-	Equivalent	7.3
3. Humidity	%	35	TCVN 5815:2000
4. pH	-	6.0 – 8.0	TCVN 5979:1995
5. Microorganism	CFU/g	10^6	7.6
6. Total Organic substance	%	> 22.	TCVN 4050:85
7. Total Nitrogen (T-N)	%	> 2.5	TCVN 5815:2001
8. Effective Phosphate (PO_4-P)	%	> 2.5	TCVN 5815:2001
9. Effective Potassium (K)	%	> 1.5	TCVN 5815:2001
10. Salmonella	CFU/25g	0.	TCVN 5815:2001
11. Lead (Pb)	mg/kg	200.	TCVN 6496:1999
12. Cadmium (Cd)	mg/kg	2.5	TCVN 6496:1999
13. Chrome (Cr)	mg/kg	200.	TCVN 6496:1999
14. Nickel (Ni)	mg/kg	100.	TCVN 6496:1999
15. Mercury (Hg)	mg/kg	2.	TCVN 5989:1995

Source: TCVN-7185:2002

(3) Buffer Zone

Buffer zone requirements are specified by QCVN-07:2010/BXD. The regulations are presented in Table A5-F-3. The extent of odor and the contents of works (transportation and storage of sludge, etc) at the composting facility are almost same as that of the sludge drying bed. Therefore the buffer zone around the composting facility has to be at least 400m in this case because STP2 has more than 50,000 m^3/day of capacity.

Table A5-F-3 National Technical Regulation on Domestic Wastewater

No.	Items	Buffer zone (m) base on capacity (×1000m^3/day)			
		< 0.2	0.2 − 5	5 − 50	>50
1.	Pumping Station	15	20	25	30
2.	Wastewater treatment plant				
a.	Physical treatment (combine with Sludge drying bed)	100	200	300	400
b.	Biological treatment (combine with Sludge drying bed)	100	150	300	400
c.	Biological treatment without Sludge drying bed (combine with Sludge drying equipment, Sludge treated equipment...)	10	15	30	40
d.	Underground sewage filter yard	100	150	300	500
e.	Sewage farming	50	200	400	1,000
f.	Biological pond	50	200		
g.	Sewage Oxidation channel	50	150		

Source: QCVN-07:2010/BXD

3. The Composting Process

Composting is an aerobic bacterial decomposition process to stabilize organic wastes and produce humus (compost). Compost contains nutrients and organic carbon which are excellent soil conditioners. The composting process is described in Table A5-F-4.

Table A5-F-4 Basic Composting Process and Function

	Pre-composting (Adjustment)	Fermentation	Post-composting
Basic Process	Dewatered Sludge → Crushed and Mixed; Additional Materials ⇢ Crushed and Mixed; Returned Compost → Crushed and Mixed	→ Primary Fermentation → Secondary Fermentation (→ Returned Compost)	→ Screening and Packing → Products
Facilities	・Various Hoppers ・Weight Scale ・Mixing Machines (dehydrator, etc)	・Fermentation Tank ・Cut Back and Transport Machine (Blower) (Odor Control Machine, etc)	・Hopper and Storage ・Conveyor ・Weight Scale (Packing Machine, etc)
Function	・To aerate and adjust water content and pH to improve the composting process. ・Add cattle dung, wood waste, and other organic materials to improve quality of the compost.	・Stabilization of sludge by fermentation. The pathogenic bacteria and parasites are killed and inactivated by high temperatures. ・Reduction of water content.	・Screening and Packing to improve handling and storage.

Source: Guideline & Explanation of Sewerage Facility Plan & Design (Japan Sewerage Works Association)

The optimum conditions for composting are a moisture content of about 50 %, a carbon to nitrogen ratio of about 25 to 30, and temperature of 55 ^{o}C. Because wastewater sludge is rich in nutrients, its carbon to nitrogen ratio is low (5 to 10). It is also high in moisture. Addition of dry sawdust, which is very high in carbon to nitrogen ratio (500) can adjust both the moisture and carbon to nitrogen ratio. Other waste materials that can be used for this purpose are mulched garden wastes, forest wastes and shredded newspaper

5. Required Area for a Composting Facilities

The capacity of composting facilities depends on the additive material and quantity in the pre-composting stage. In this study it is assumed that a pre-composting process will take place to adjust the quality and moisture content of the sludge. It is assumed that additive materials will be 30% of the dewatered sludge volume. The quantities for capacity calculation are as follows.

Dewatered sludge volume = 52.0 m^3(t)/day (moisture content 76.0% from STP2)
Additive rate = 30%
Additive material volume = 15.6 m^3(t)/day (=52.0×0.3)
Total volume = 67.6 m^3(t)/day (=52.0+15.6)

The fermentation process has generally two stages as primary fermentation and secondary fermentation. The normal period for fermentation is as follows.

Primary fermentation period : 10 days (10 – 14 days)
Secondary fermentation period : 45 days (30 – 60 days for natural aeration using windrow)
Total required period : 55 days

These are based on Guideline & Explanation of Sewerage Facility Plan & Design (Japan Sewerage Works Association).

Therefore the fermenting tank capacity is calculated as follows (without water reduction).

Tank volume = 67.6 m^3/day × 55 days = 3,718 m^3

Average height of fermenting Tank = 1.5m (0 – 3.0m)

Required area for fermenting tank = 3,718m^3 / 1.5 m = 2,480 m^2

Required area for pre-composting and post-composting = 2,480 m^2

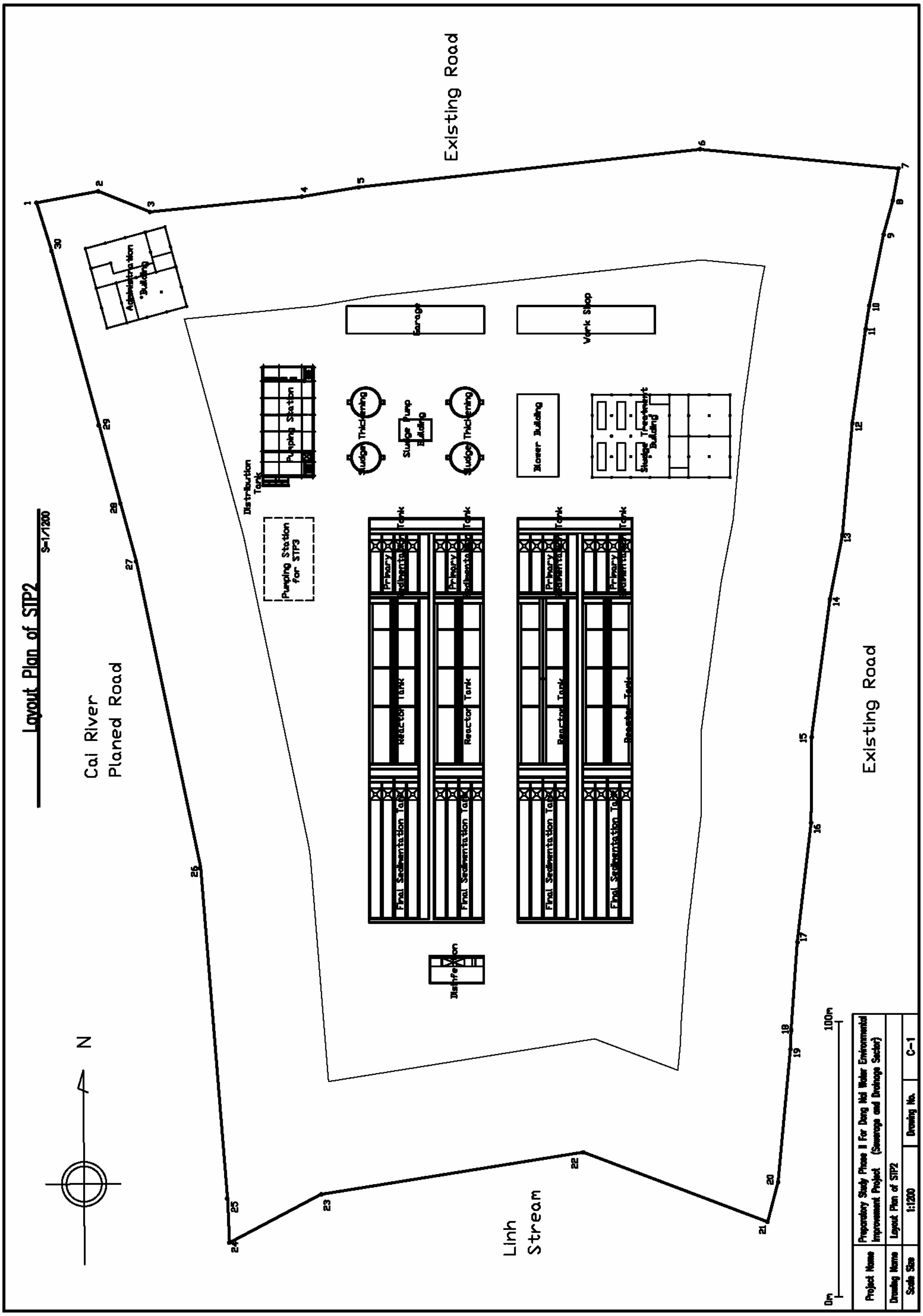
(for storage, garage, office, etc)

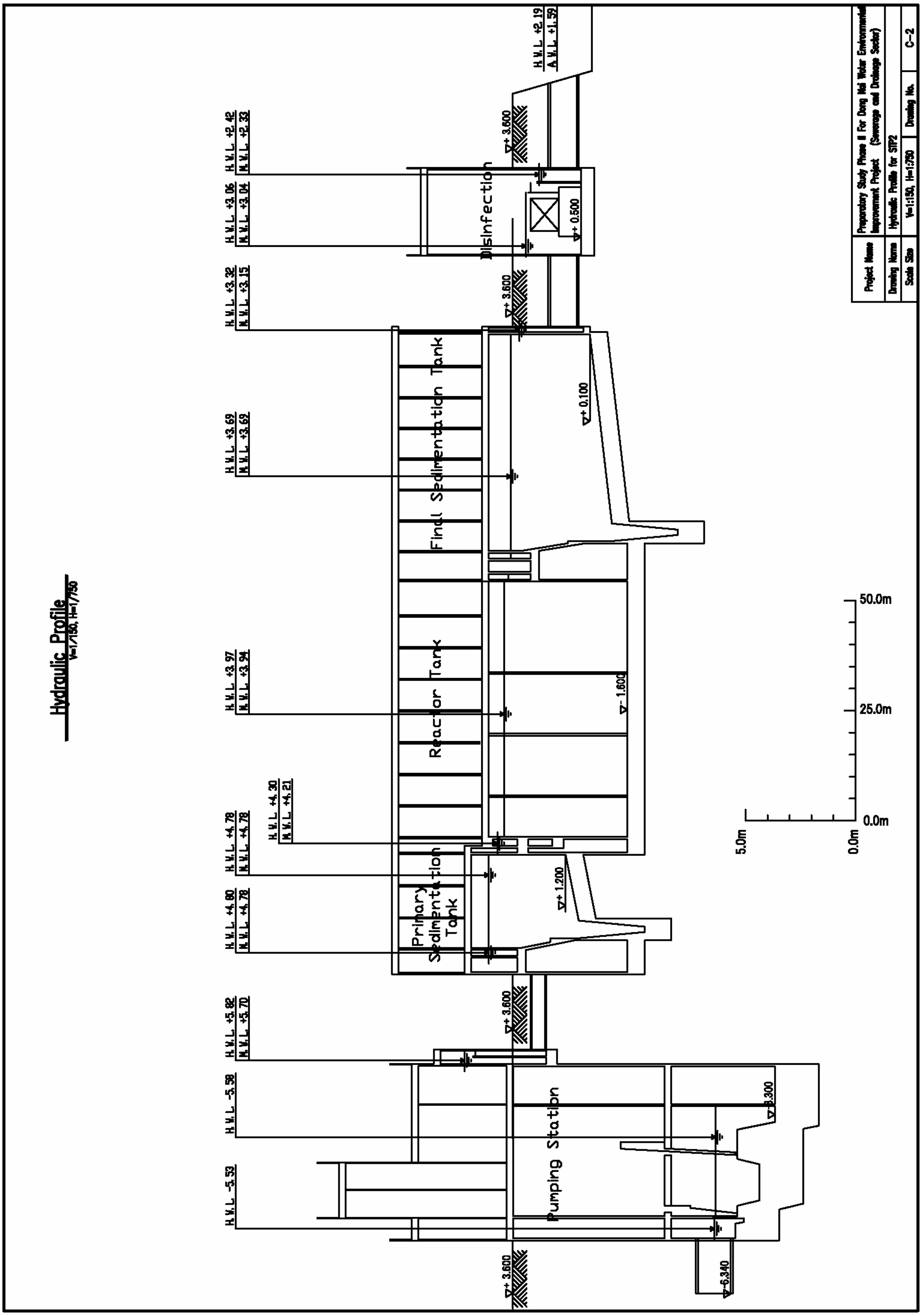
Total required area = about 5,000 m^2 (70m × 70m) without 400m buffer zone

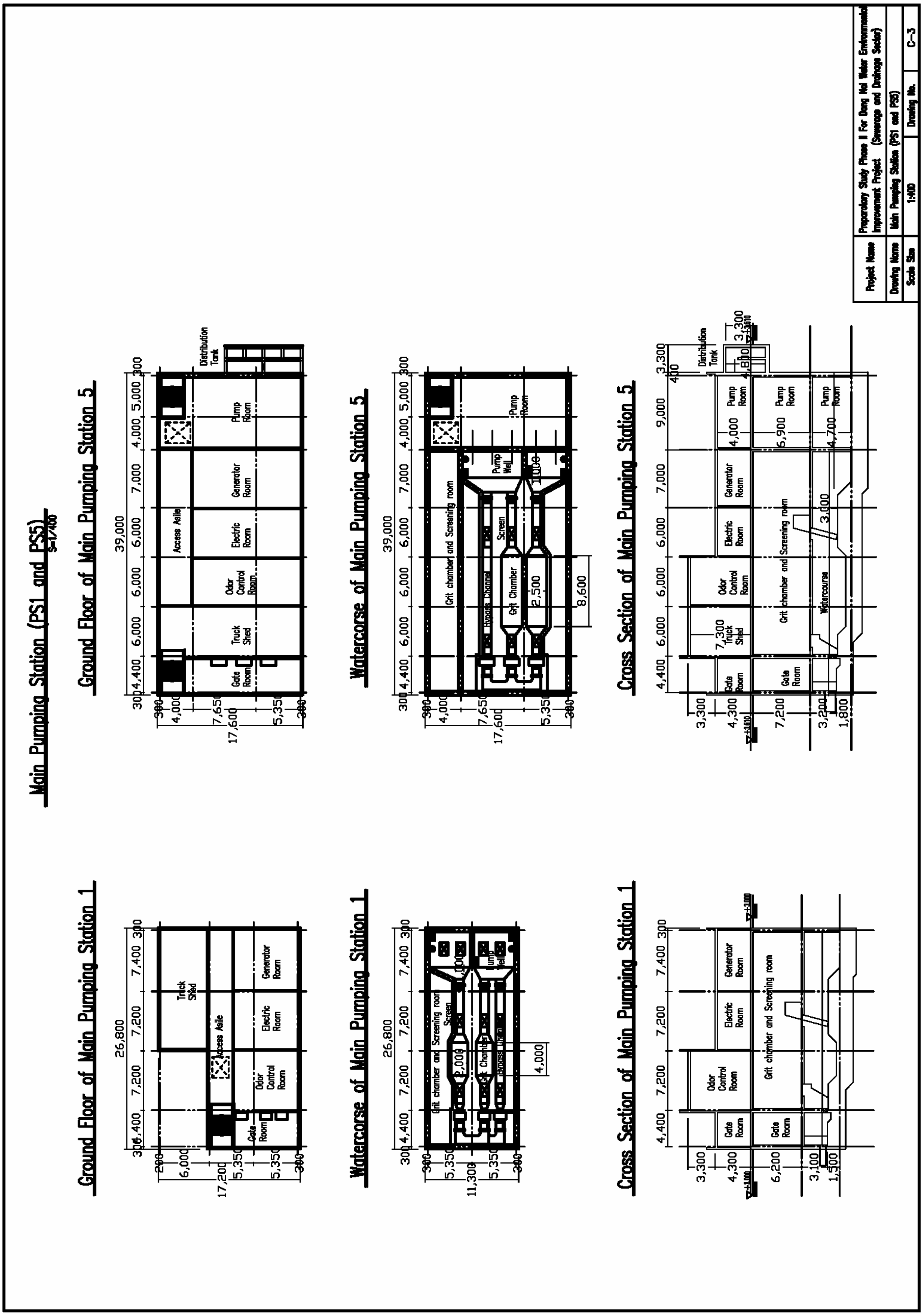
Based on these calculations, the minimum required area with buffer zone is about 760,000m^2 (870m × 870m).

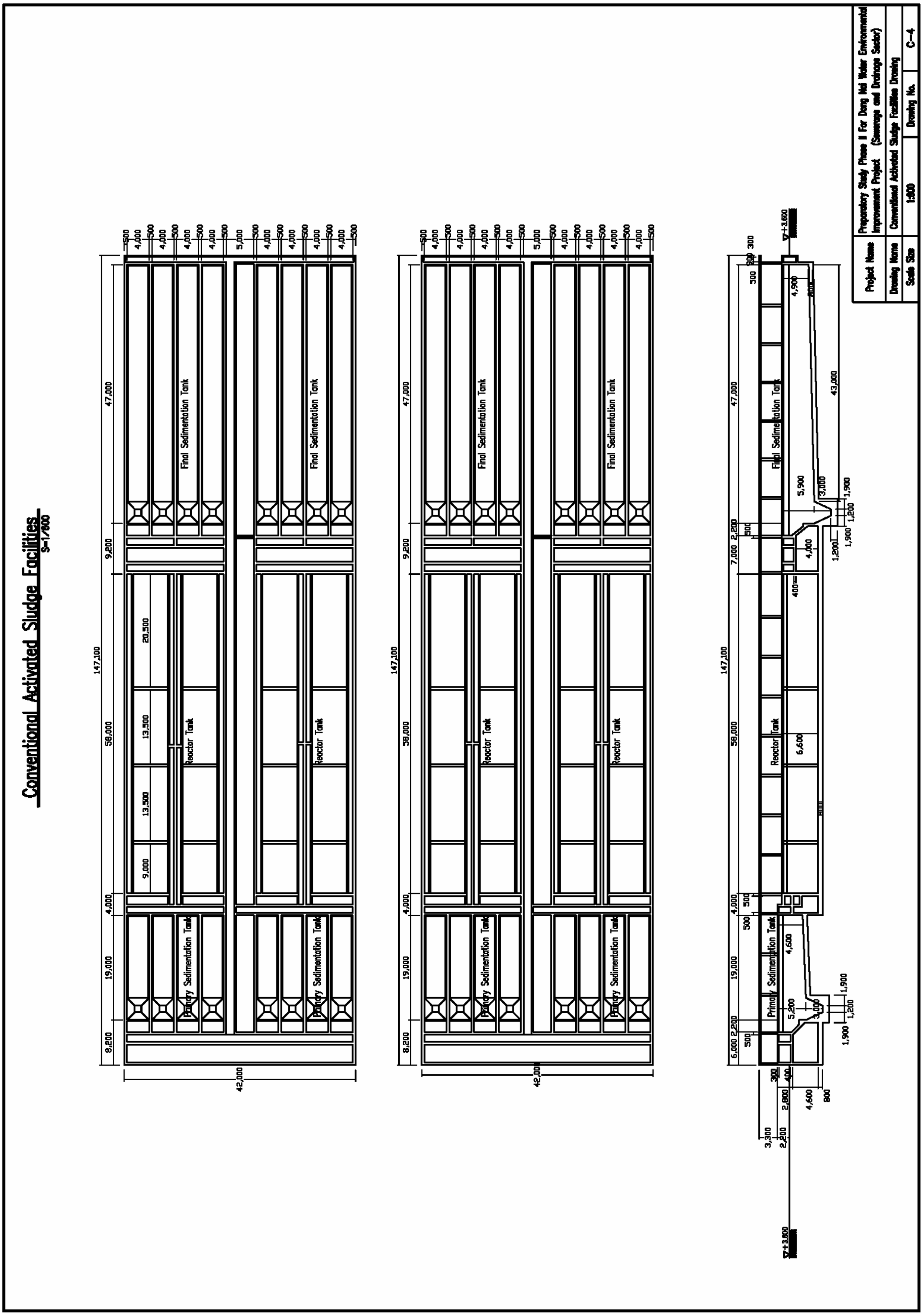
Appendix 5-G

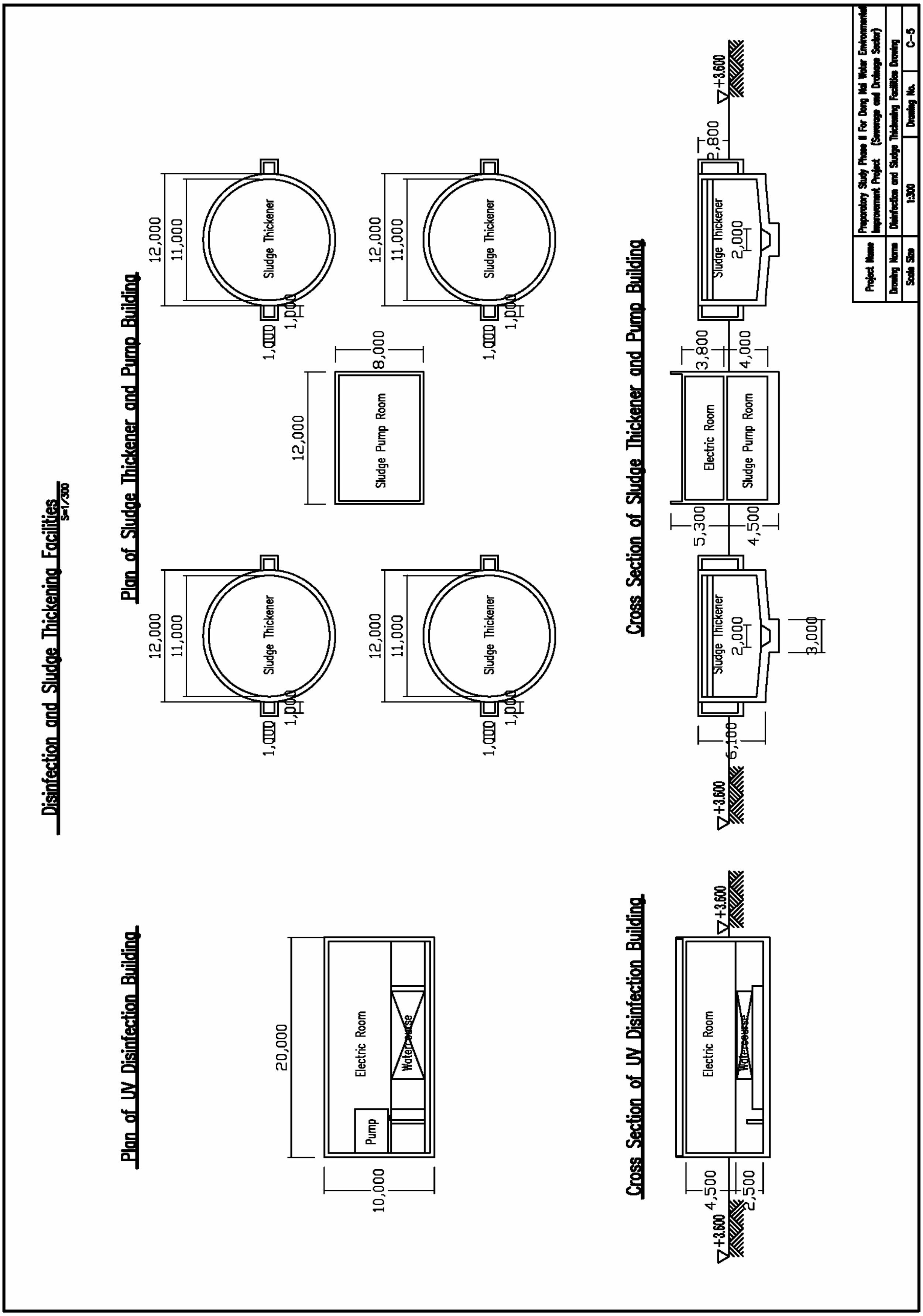
Drawing of STP and PS

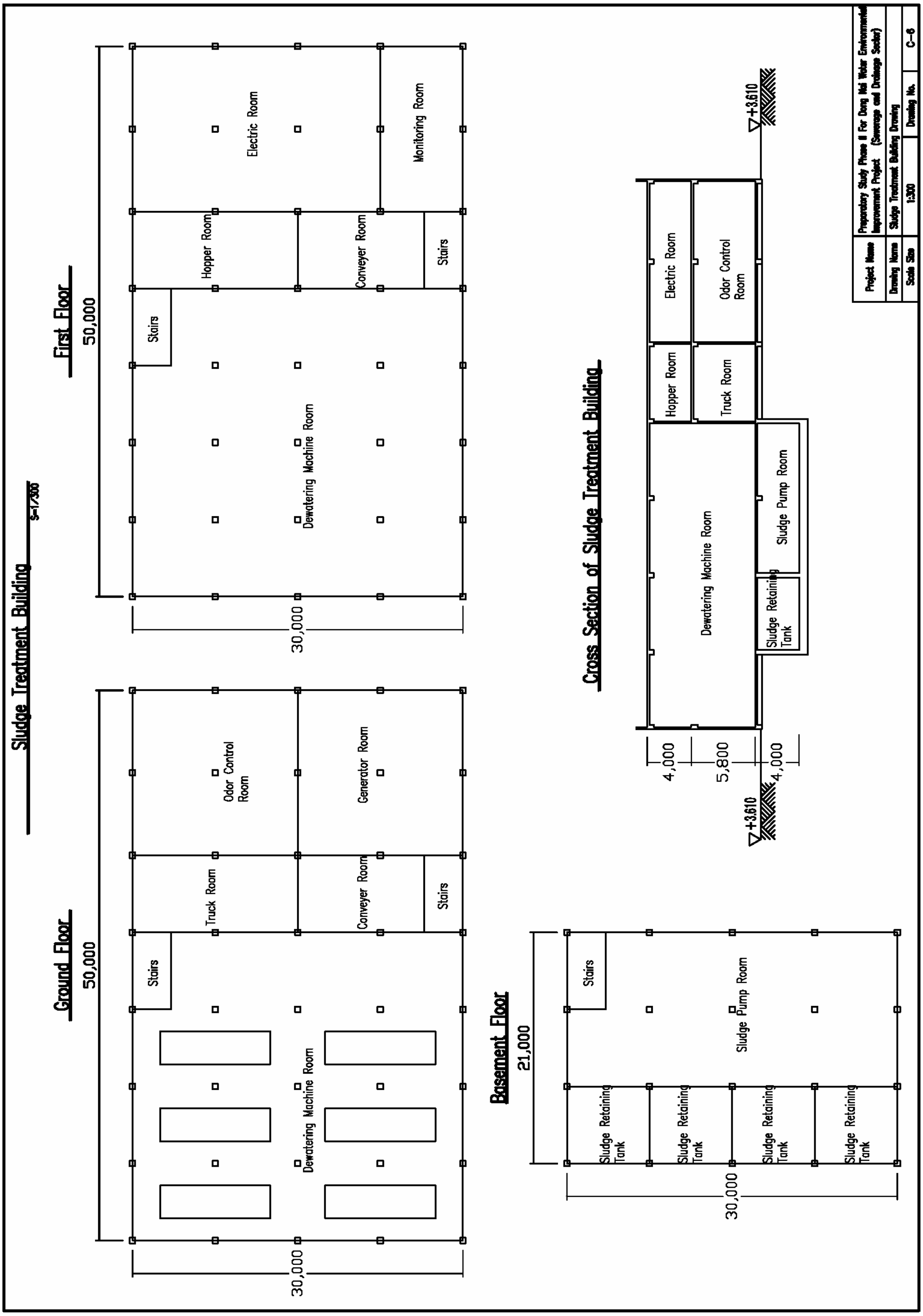

Layout Plan of STP2
S=1/1200
Existing Road
Cai River
Planed Road
Existing Road
Linh Stream
N
Administration Building
Garage
Work Shop
Pumping Station
Distribution Tank
Sludge Thickening
Sludge Pump Building
Sludge Thickening
Blower Building
Sludge Treatment Building
Pumping Station for STP3
Primary Sedimentation Tank
Reactor Tank
Final Sedimentation Tank
Disinfection
0m
100m
Project Name
Preparatory Study Phase II For Dong Nai Water Environmental Improvement Project (Sewerage and Drainage Sector)
Drawing Name
Layout Plan of STP2
Scale Size
1:1200
Drawing No.
C-1


Hydraulic Profile
V=1/150, H=1/750
Pumping Station
Primary Sedimentation Tank
Reactor Tank
Final Sedimentation Tank
Disinfection
H.W.L -5.53
H.W.L -5.58
H.W.L +5.82
N.W.L +5.70
H.W.L +4.80
N.W.L +4.78
H.W.L +4.78
N.W.L +4.78
H.W.L +4.30
N.W.L +4.21
H.W.L +3.97
N.W.L +3.94
H.W.L +3.69
N.W.L +3.69
H.W.L +3.32
N.W.L +3.15
H.W.L +3.06
N.W.L +3.04
H.W.L +2.42
N.W.L +2.33
H.W.L +2.19
A.W.L +1.59
+3.600
-6.340
-3.300
+1.200
-1.600
+0.100
+0.500
50.0m
25.0m
0.0m
5.0m
Project Name
Drawing Name
Hydraulic Profile for STP2
Scale Size
V=1:150, H=1:750
Drawing No.
C-2


Main Pumping Station (PS1 and PS5)
S=1/400
Ground Floor of Main Pumping Station 5
Watercorse of Main Pumping Station 5
Cross Section of Main Pumping Station 5
Ground Floor of Main Pumping Station 1
Watercorse of Main Pumping Station 1
Cross Section of Main Pumping Station 1
Distribution Tank
Pump Room
Generator Room
Electric Room
Odor Control Room
Truck Shed
Gate Room
Access Aisle
Pump Well
Screen
Grit Chamber
Bypass Channel
Grit chamber and Screening room
Watercourse
39,000
26,800
Project Name
Preparatory Study Phase II For Dong Nai Water Environmental Improvement Project (Sewerage and Drainage Sector)
Drawing Name
Main Pumping Station (PS1 and PS5)
Scale Size
1:400
Drawing No.
C-3


Conventional Activated Sludge Facilities
S=1/600
Final Sedimentation Tank
Reactor Tank
Primary Sedimentation Tank
147,100
42,000
Project Name
Preparatory Study Phase II For Dong Nai Water Environmental Improvement Project (Sewerage and Drainage Sector)
Drawing Name
Conventional Activated Sludge Facilities Drawing
Scale Size
1:800
Drawing No.
C-4

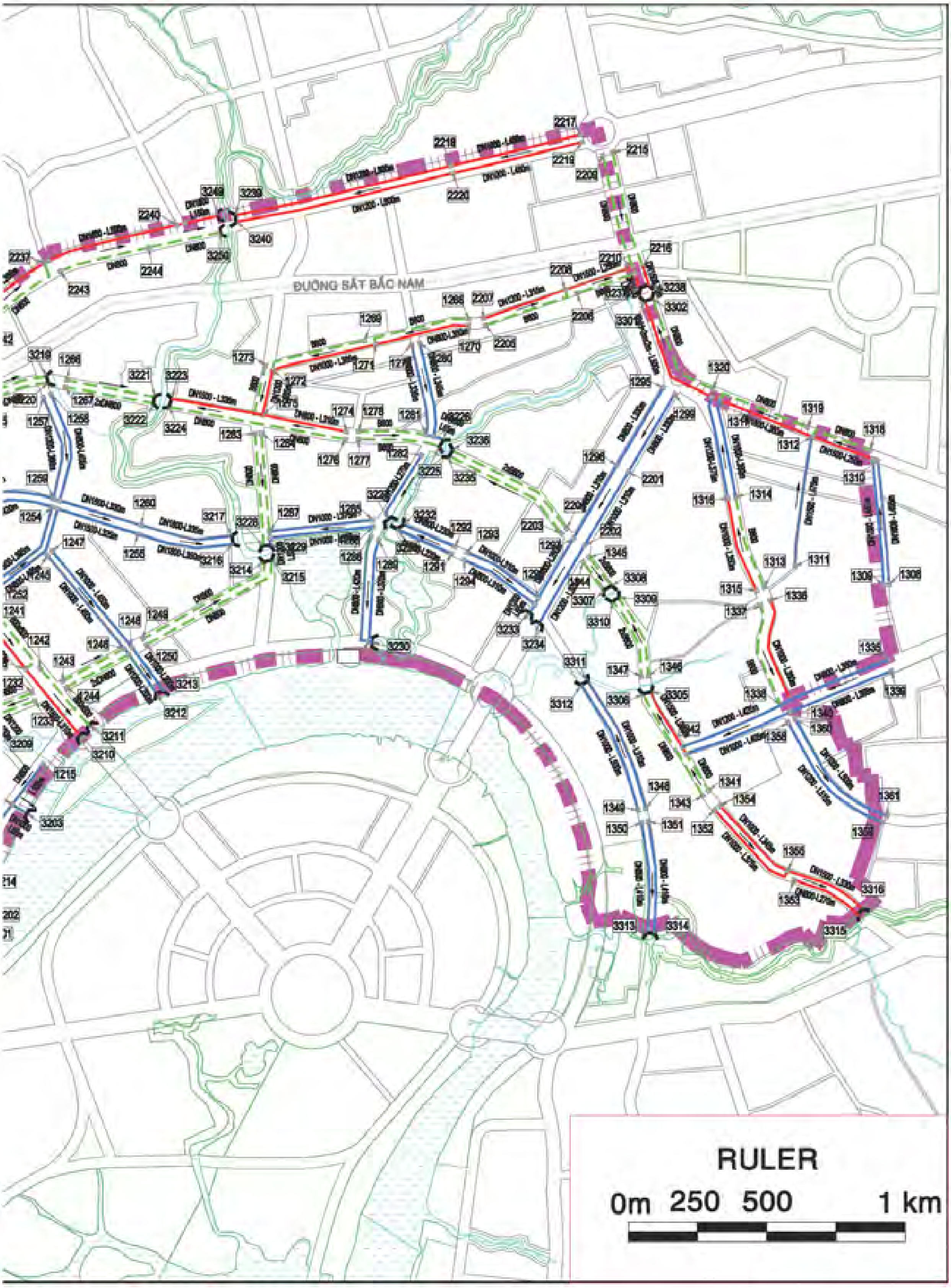

Disinfection and Sludge Thickening Facilities
S=1/300
Plan of Sludge Thickener and Pump Building
Sludge Thickener
Sludge Pump Room
12,000
11,000
1,000
8,000
Cross Section of Sludge Thickener and Pump Building
Electric Room
2,000
2,800
3,800
4,000
5,300
4,500
3,000
6,100
+3.600
Plan of UV Disinfection Building
Electric Room
Watercourse
Pump
20,000
10,000
Cross Section of UV Disinfection Building
2,500
Project Name
Preparatory Study Phase II For Dong Nai Water Environmental Improvement Project (Sewerage and Drainage Sector)
Drawing Name
Disinfection and Sludge Thickening Facilities Drawing
Scale Size
1:300
Drawing No.
C-5


Sludge Treatment Building
S=1/300
First Floor
50,000
30,000
Electric Room
Monitoring Room
Hopper Room
Conveyer Room
Stairs
Stairs
Dewatering Machine Room
Ground Floor
50,000
30,000
Odor Control Room
Generator Room
Truck Room
Conveyer Room
Stairs
Stairs
Dewatering Machine Room
Basement Floor
21,000
30,000
Stairs
Sludge Pump Room
Sludge Retaining Tank
Sludge Retaining Tank
Sludge Retaining Tank
Sludge Retaining Tank
Cross Section of Sludge Treatment Building
+3,610
+3,610
Electric Room
Odor Control Room
Hopper Room
Truck Room
Dewatering Machine Room
Sludge Pump Room
Sludge Retaining Tank
4,000
5,800
4,000
Project Name
Preparatory Study Phase II For Dong Nai Water Environmental Improvement Project (Sewerage and Drainage Sector)
Drawing Name
Sludge Treatment Building Drawing
Scale Size
1:300
Drawing No.
C-6

Appendix 6-A

Plan Drawing of Stormwater


N


ĐƯỜNG SẮT BẮC NAM
RULER
0m 250 500 1 km

Appendix 6-B

Hydraulic Calculation Sheet of Drainage System

Appendix 6-B Hydraulic Calcilation Sheet of Drainage System

Pipe		Length	Subcatchment area (ha)				$t_0 + t_1$	t_2	t	q	C	j	k_{cmax}	Discharge (m^3/s ec)				i_{pipe}	Velocity	n	Type	Diameter	Depth	Ground Level		Invert Level		Remarks
From	To		Itself		Transfer	Total	min	min	min	l/sec.ha				Run-off	Domestic (ave)	Domestic (peak)	Q_{total}	(m/m)	(m/sec)			(m)	h (m)	From (m)	To (m)	From (m)	To (m)	
		m	name	Area																								
Catchment No.1 Combined system																												
1146	1151	270	1146	2.5		2.5	10.00	3.79	13.79	361.8256	0.74	1	2.50	0.656	0.001	0.003	0.659	0.0013	1.212	0.013	tròn/pipe	1.0	0.653	3.50	3.35	1.92	1.57	Existing
1148	1151	220	1148	1.5		1.5	10.00	3.52	13.52	363.851	0.74	1	2.50	0.398	0.001	0.002	0.400	0.0013	1.063	0.013	tròn/pipe	0.8	0.561	3.50	3.35	1.92	1.63	Existing
1149	1151	340	1149	7.1		7.1	10.00	2.17	12.17	374.4369	0.74	1	2.30	1.962	0.003	0.007	1.969	0.0060	2.667	0.013	tròn/pipe	1.0	0.890	5.28	3.35	3.48	1.44	
1150	1151	340	1150	3.7		3.7	10.00	2.49	12.49	371.8621	0.74	1	2.50	1.021	0.002	0.004	1.025	0.0060	2.323	0.013	tròn/pipe	0.8	0.656	5.28	3.35	3.70	1.66	
1151	1156	400	1151	2.6	14.7	17.3	13.79	3.75	17.54	335.7733	0.74	1	2.30	4.304	0.007	0.017	4.320	0.0008	1.815	0.013	tròn/pipe	2.0	1.417	3.35	3.11	0.94	0.62	
1147	1156	405	1147	2.6		2.6	10.00	5.66	15.66	348.3203	0.74	1	2.50	0.670	0.001	0.003	0.673	0.0013	1.217	0.013	tròn/pipe	1.0	0.663	3.35	3.11	1.77	1.24	Existing
1152	1153	255	1152	1.0		1.0	10.00	2.59	12.59	371.0182	0.74	1	2.50	0.264	0.000	0.001	0.265	0.0055	1.671	0.013	tròn/pipe	0.6	0.328	7.20	5.84	5.62	4.22	Existing
1153	1156	410	1153	3.1	1.0	4.1	12.59	2.84	15.43	349.8863	0.74	1	2.50	1.059	0.002	0.004	1.063	0.0067	2.455	0.013	tròn/pipe	0.8	0.643	5.84	3.11	4.22	1.47	Existing
1154	1155	255	1154	2.0		2.0	10.00	2.14	12.14	374.6177	0.74	1	2.50	0.566	0.001	0.002	0.568	0.0055	2.022	0.013	tròn/pipe	0.8	0.437	7.20	5.84	5.62	4.22	Existing
1155	1156	410	1155	3.0	2.0	5.1	12.14	2.59	14.74	354.8348	0.74	1	2.50	1.329	0.002	0.005	1.334	0.0067	2.687	0.013	tròn/pipe	1.0	0.605	5.84	3.11	4.22	1.47	Existing
1156	3119	245	1156	3.3	29.1	32.4	17.54	2.63	20.17	319.6444	0.74	1	2.00	7.654	0.014	0.028	7.682	0.0010	0.675	0.013	hộp/box culvert	3.0×2.5	1.518	3.11	2.85	-0.38	-0.63	=B×H: Exi., Flap gate
1157	3120	310	1157	2.5		2.5	10.00	1.54	11.54	379.5342	0.74	1	2.50	0.711	0.001	0.003	0.713	0.0095	3.417	0.013	tròn/pipe	0.6	0.415	6.51	3.70	5.15	2.21	Existing, Flap gate
1158	3121	310	1158	1.7		1.7	10.00	2.26	12.26	373.7072	0.74	1	2.50	0.459	0.001	0.002	0.461	0.0095	2.335	0.013	tròn/pipe	0.6	0.395	6.51	3.70	4.93	1.99	Existing, Flap gate
1159	3122	310	1159	2.3		2.3	10.00	1.79	11.79	377.4678	0.74	1	2.50	0.631	0.001	0.002	0.634	0.0145	2.939	0.013	tròn/pipe	0.6	0.428	6.82	2.40	5.24	0.75	Existing, Flap gate
1160	3123	310	1160	1.6		1.6	10.00	1.92	11.92	376.464	0.74	1	2.50	0.454	0.001	0.002	0.456	0.0145	2.751	0.013	tròn/pipe	0.6	0.341	6.82	2.40	5.46	0.97	Existing, Flap gate
1161	1164	265	1161	1.4		1.4	10.00	4.03	14.03	360.0024	0.74	1	2.50	0.381	0.001	0.002	0.382	0.0015	1.117	0.013	tròn/pipe	0.8	0.515	6.93	6.54	5.35	4.95	Existing
1162	1164	265	1162	0.9		0.9	10.00	4.71	14.71	355.0398	0.74	1	2.50	0.244	0.000	0.001	0.245	0.0015	0.956	0.013	tròn/pipe	0.6	0.511	6.93	6.54	5.35	4.95	Existing
1163	1164	245	1163	4.3		4.3	10.00	3.36	13.36	365.0598	0.74	1	2.50	1.151	0.002	0.005	1.155	0.0010	1.239	0.013	tròn/pipe	1.2	0.922	6.64	6.54	4.84	4.60	
1164	3124	335	1164	2.4	6.6	9.0	14.71	1.51	16.22	344.4691	0.74	1	2.10	2.294	0.004	0.008	2.302	0.0120	3.769	0.013	tròn/pipe	1.0	0.726	6.54	2.40	4.60	0.57	
	3124-O	10				10.8			16.22	344.4691	0.74	1	2.50	2.740	0.005	0.011	2.752	0.0100	3.447	0.013	tròn/pipe	1.2						Flap gate
1165	3125	270	1165	1.8		1.8	10.00	1.60	11.60	379.0745	0.74	1	2.50	0.491	0.001	0.002	0.493	0.0155	2.873	0.013	tròn/pipe	0.6	0.350	6.54	2.40	4.96	0.78	Existing
1177	3128	200	1177	2.3		2.3	10.00	1.31	11.31	381.4533	0.74	1	2.50	0.658	0.001	0.002	0.660	0.0110	2.592	0.013	tròn/pipe	0.6	0.507	4.57	2.40	3.21	1.01	Existing, Flap gate
1178	3129	200	1178	1.5		1.5	10.00	1.41	11.41	380.6597	0.74	1	2.50	0.411	0.001	0.002	0.413	0.0110	2.417	0.013	tròn/pipe	0.6	0.349	4.57	2.40	3.21	1.01	Existing, Flap gate
1166	1169	80	1166	0.5		0.5	10.00	1.51	11.51	379.7751	0.74	1	2.50	0.126	0.000	0.000	0.127	0.0095	0.899	0.013	tròn/pipe	0.6	0.300	6.54	5.79	4.96	4.20	Existing
1167	1169	260	1167	1.7		1.7	10.00	4.10	14.10	359.5155	0.74	1	2.50	0.447	0.001	0.002	0.449	0.0013	1.079	0.013	tròn/pipe	0.8	0.617	6.12	5.79	4.54	4.20	Existing
1168	1169	270	1168	2.0		2.0	10.00	3.50	13.50	363.9929	0.74	1	2.50	0.528	0.001	0.002	0.530	0.0013	1.311	0.013	tròn/pipe	0.8	0.600	6.12	5.79	4.54	4.19	Existing
1169	1174	265	1169	0.8	4.1	4.9	14.10	1.44	15.54	349.171	0.74	1	2.50	1.274	0.002	0.005	1.279	0.0110	3.131	0.013	tròn/pipe	0.8	0.606	5.79	2.98	4.19	1.27	Existing
1171	1174	255	1171	4.3		4.3	10.00	2.49	12.49	371.8344	0.74	1	2.50	1.169	0.002	0.005	1.174	0.0025	1.740	0.013	tròn/pipe	1.0	0.802	3.10	2.98	1.74	1.10	=B×H: Exi.
1175	1174	385	1175	1.2		1.2	10.00	3.05	13.05	367.4628	0.74	1	2.50	0.315	0.000	0.001	0.317	0.0095	2.147	0.013	tròn/pipe	0.6	0.310	6.54	2.98	4.96	1.30	Existing
1170	1173	320	1170	2.6		2.6	10.00	3.98	13.98	360.4163	0.74	1	2.50	0.704	0.001	0.003	0.707	0.0017	1.368	0.013	tròn/pipe	1.0	0.625	2.40	2.50	1.04	0.50	=B×H: Exi.
1172	1173	270	1172	3.6		3.6	10.00	4.18	14.18	358.9439	0.74	1	2.50	0.962	0.002	0.004	0.965	0.0008	1.099	0.013	tròn/pipe	1.2	0.870	2.40	2.50	0.38	0.16	
1173	1174	300	1173	4.9	6.3	11.2	14.18	3.26	17.44	336.4078	0.74	1	2.50	2.778	0.005	0.012	2.790	0.0007	1.564	0.013	tròn/pipe	1.8	1.189	2.50	2.98	0.16	-0.05	
1174	3126	215	1174	1.1	21.5	22.6	17.44	1.58	19.02	326.4949	0.74	1	2.10	5.455	0.010	0.020	5.476	0.0013	2.311	0.013	tròn/pipe	2.0	1.411	2.98	2.40	-0.05	-0.33	
	3126-O	10				24.5			19.02	326.4949	0.74	1	2.10	5.927	0.010	0.022	5.949	0.0020	2.167	0.013	tròn/pipe	2.0						Flap gate
1176	3127	125	1176	2.0		2.0	10.00	1.10	11.10	383.2687	0.74	1	2.50	0.553	0.001	0.002	0.555	0.0050	1.940	0.013	tròn/pipe	0.8	0.444	2.98	2.40	1.62	1.00	Existing
1179	1183	95	1179	0.9		0.9	10.00	1.10	11.10	383.2472	0.74	1	2.50	0.258	0.000	0.001	0.259	0.0040	1.471	0.013	tròn/pipe	0.6	0.358	2.98	2.60	1.40	1.02	Existing
1180	1183	95	1180	0.2		0.2	10.00	3.68	13.68	362.6328	0.74	1	2.50	0.062	0.000	0.000	0.062	0.0040	0.439	0.013	tròn/pipe	0.6	0.300	2.98	2.60	1.40	1.02	Existing
1181	1183	100	1181	0.8		0.8	10.00	1.10	11.10	383.2719	0.74	1	2.50	0.218	0.000	0.001	0.219	0.0055	1.552	0.013	tròn/pipe	0.6	0.300	3.15	2.60	1.57	1.02	Existing
1182	1183	100	1182	0.4		0.4	10.00	2.10	12.10	374.952	0.74	1	2.50	0.114	0.000	0.000	0.114	0.0055	0.809	0.013	tròn/pipe	0.6	0.300	3.15	2.60	1.57	1.02	Existing
1183	3130	135	1183	0.8	2.3	3.2	13.68	1.72	15.40	350.1228	0.74	1	2.50	0.816	0.001	0.003	0.819	0.0015	1.335	0.013	tròn/pipe	1.0	0.730	2.60	2.40	0.82	0.62	Existing, Flap gate
1188	1190	610	1188	2.8		2.8	10.00	6.31	16.31	343.8378	0.74	1	2.50	0.710	0.001	0.003	0.713	0.0030	1.643	0.013	tròn/pipe	0.8	0.645	5.08	3.32	3.50	1.67	Existing
1189	1190	610	1189	2.8		2.8	10.00	6.31	16.31	343.8378	0.74	1	2.50	0.710	0.001	0.003	0.713	0.0030	1.643	0.013	tròn/pipe	0.8	0.645	5.08	3.32	3.50	1.67	Existing
1190	3132	120	1190	0.7	5.6	6.3	16.31	1.35	17.66	334.9803	0.74	1	2.30	1.564	0.003	0.006	1.570	0.0015	1.515	0.013	tròn/pipe	1.2	1.034	3.32	3.14	1.47	1.29	Existing, Flap gate
1191	1193	420	1191	3.3		3.3	10.00	5.69	15.69	348.0952	0.74	1	2.50	0.842	0.001	0.003	0.846	0.0013	1.255	0.013	tròn/pipe	1.0	0.801	4.90	4.64	3.32	2.77	
1192	1193	455	1192	3.7		3.7	10.00	5.74	15.74	347.7378	0.74	1	2.50	0.939	0.002	0.004	0.943	0.0015	1.347	0.013	tròn/pipe	1.0	0.835	4.90	4.64	3.32	2.64	
1193	3133	50			6.9	6.9	15.74	0.55	16.29	344.0037	0.74	1	2.50	1.762	0.003	0.007	1.769	0.0013	1.558	0.013	tròn/pipe	1.5	0.919	4.64	4.50	2.64	2.57	
1194	3134	390	1194	2.2		2.2	10.00	3.26	13.26	365.8628	0.74	1	2.50	0.582	0.001	0.002	0.584	0.0055	2.036	0.013	tròn/pipe	0.8	0.445	4.51	2.40	3.15	1.01	
1195	3135	390	1195	4.2		4.2	10.00	2.75	12.75	369.8152	0.74	1	2.50	1.158	0.002	0.004	1.162	0.0055	2.413	0.013	tròn/pipe	1.0	0.589	4.51	2.40	2.93	0.79	
	3135-O	10				6.4			12.75	369.8152	0.74	1	2.50	1.746	0.003	0.007	1.753	0.0025	1.724	0.013	tròn/pipe	1.2						Flap gate
1184	1196	315	1184	5.7		5.7	10.00	2.79	12.79	369.4437	0.74	1	2.50	1.558	0.002	0.006	1.564	0.0025	1.916	0.013	tròn/pipe	1.2	0.814	3.23	2.44	1.43	0.64	
1196	3136	425	1196	3.5	5.7	9.2	12.79	4.42	17.21	337.8721	0.74	1	2.10	2.300	0.004	0.008	2.308	0.0008	1.635	0.013	tròn/pipe	1.8	0.978	2.44	2.40	0.44	0.10	
1185	1197	350	1185	2.2		2.2	10.00	2.97	12.97	368.107	0.74	1	2.50	0.599	0.001	0.002	0.602	0.0052	2.006	0.013	tròn/pipe	0.8	0.461	4.19	2.40	2.83	1.01	
1186	1197	340	1186	4.9		4.9	10.00	2.35	12.35	372.9521	0.74	1	2.50	1.358	0.002	0.005	1.363	0.0053	2.458	0.013	tròn/pipe	1.0	0.665	4.19	2.40	2.61	0.81	
1187	1197	350	1187	2.1		2.1	10.00	3.73	13.73	362.2334	0.74	1	2.50	0.563	0.001	0.002	0.565	0.0030	1.593	0.013	tròn/pipe	0.8	0.532	3.32	2.40	1.74	0.69	
1197	3137	400	1197	6.1	9.2	15.4	13.73	4.04	17.77	334.2525	0.74	1	2.30	3.797	0.007	0.015	3.812	0.0007	1.684	0.013	tròn/pipe	2.0	1.354	2.40	2.40	-0.01	-0.29	
	3137-O	10				24.6			17.77	334.2525	0.74	1	2.10	6.072	0.010	0.022	6.094	0.0010	1.730	0.013	hộp/box culvert	1×2.0×2.0						Flap gate
1198	3138	290	1198	2.2		2.2	10.00	4.15	14.15	359.1248	0.74	1	2.50	0.595	0.001	0.002	0.598	0.0013	1.188	0.013	tròn/pipe	1.0	0.611	2.50	2.40	0.92	0.54	Existing
1199	3139	290	1199	5.0		5.0	10.00	4.49	14.49	356.6699	0.74	1	2.50	1.320	0.002	0.005	1.325	0.0010	1.211	0.013	tròn/pipe	1.2	1.112	2.50	2.40	0.70	0.41	
	3139-O	10				7.2			14.49	356.6699	0.74	1	2.50	1.911	0.003	0.008	1.919	0.0010	1.265	0.013	tròn/pipe	1.5						Flap gate
2102	2103	380	2102	8.5		8.5	10.00	4.21	14.21	358.7033	0.74	1	2.50	2.267	0.004	0.009	2.276	0.0007	1.535	0.013	tròn/pipe	1.8	1.017	2.40	2.40	0.38	0.11	
2103	3140	145	2103	1.2	8.5	9.8	14.21	1.59	15.80	347.3376	0.74	1	2.50	2.509	0.004	0.010	2.519	0.0007	1.547	0.013	tròn/pipe	1.8	1.099	2.40	2.40	-0.19	-0.29	Flap gate
2104	3141	560	2104	7.5		7.5	10.00	2.53	12.53	371.5325	0.74	1	2.50	2.051	0.003	0.008	2.059	0.0125	3.763	0.013	tròn/pipe	1.0	0.657	9.36	2.44	7.78	0.78	Existing, Flap gate
2105	3142	580	2105	5.1		5.1	10.00	3.01	13.01	367.8	0.74	1	2.50	1.377	0.002	0.005	1.383	0.0120	3.281	0.013	tròn/pipe	0.8	0.625	9.36	2.44	7.78	0.82	Existing, Flap gate

Appendix 6-B Hydraulic Calcilation Sheet of Drainage System

Pipe			Subcatchment area (ha)				$t_0 + t_1$	t_2	t	q	C	j	k_{cmax}	Discharge (m^3/s ec)				i_{pipe}	Velocity	n	Type	Diameter	Depth	Ground Level		Invert Level		Remarks
From	To	Length	Itself		Transfer	Total	min	min	min	l/sec.ha				Run-off	Domestic (ave)	Domestic (peak)	Q_{total}	(m/m)	(m/sec)			(m)	h (m)	From (m)	To (m)	From (m)	To (m)	
		m	name	Area																								
2106	2108	350	2106	3.7		3.7	10.00	2.31	12.31	373.2776	0.74	1	2.50	1.017	0.002	0.004	1.020	0.0075	2.575	0.013	tròn/pipe	0.8	0.588	4.97	2.40	3.61	0.98	=B×H: Exi.
2107	2108	350	2107	4.2		4.2	10.00	2.29	12.29	373.4309	0.74	1	2.50	1.150	0.002	0.004	1.154	0.0075	2.596	0.013	tròn/pipe	0.8	0.661	4.97	2.40	3.61	0.98	=B×H: Exi.
2108	3143	120	2108	1.3	7.8	9.1	12.31	1.12	13.43	364.5432	0.74	1	2.50	2.452	0.004	0.010	2.462	0.0010	1.824	0.013	tròn/pipe	1.8	0.943	2.40	2.40	0.58	0.46	Flap gate
2109	2111	385	2109	4.9		4.9	10.00	2.86	12.86	368.9465	0.74	1	2.50	1.330	0.002	0.005	1.335	0.0045	2.290	0.013	tròn/pipe	1.0	0.695	6.26	4.78	4.68	2.95	Existing
2110	2111	365	2110	1.8		1.8	10.00	2.51	12.51	371.6813	0.74	1	2.50	0.490	0.001	0.002	0.491	0.0042	2.471	0.013	tròn/pipe	0.6	0.398	6.26	4.78	4.68	3.15	Existing
2111	3144	175	2111	0.9	6.7	7.5	12.86	1.12	13.98	360.4225	0.74	1	2.50	2.011	0.003	0.008	2.019	0.0050	2.662	0.013	tròn/pipe	1.2	0.763	4.78	3.67	2.95	2.07	Existing
2112	2114	225	2112	0.8		0.8	10.00	3.02	13.02	367.6809	0.74	1	2.50	0.218	0.000	0.001	0.219	0.0030	1.266	0.013	tròn/pipe	0.6	0.352	5.43	4.78	3.85	3.18	Existing
2113	2114	270	2113	4.3		4.3	10.00	2.42	12.42	372.3745	0.74	1	2.50	1.185	0.002	0.005	1.189	0.0030	1.894	0.013	tròn/pipe	1.0	0.746	5.43	4.78	3.85	3.04	Existing
2114	3145	175	2114	1.0	5.1	6.1	13.02	1.08	14.10	359.5058	0.74	1	2.50	1.623	0.003	0.006	1.629	0.0065	2.759	0.013	tròn/pipe	1.0	0.704	4.78	3.67	3.04	1.90	Existing, Flap gate
2115	2118	360	2115	3.8		3.8	10.00	4.53	14.53	356.3091	0.74	1	2.50	0.997	0.002	0.004	1.001	0.0013	1.350	0.013	tròn/pipe	1.2	0.748	5.94	5.61	4.36	3.89	
2116	2118	360	2116	2.4		2.4	10.00	5.10	15.10	352.2523	0.74	1	2.50	0.626	0.001	0.003	0.628	0.0013	1.200	0.013	tròn/pipe	1.0	0.632	5.94	5.61	4.36	3.89	
2117	2118	140	2117	2.1		2.1	10.00	0.91	10.91	384.8052	0.74	1	2.50	0.609	0.001	0.002	0.612	0.0085	2.602	0.013	tròn/pipe	0.6	0.465	6.76	5.61	5.40	4.21	
2118	2124	515	2118	8.8	8.3	17.1	15.10	2.76	17.86	333.7188	0.74	1	2.30	4.233	0.007	0.017	4.250	0.0050	3.175	0.013	tròn/pipe	1.5	1.063	5.61	3.10	3.19	0.62	
2119	2122	195	2119	1.4		1.4	10.00	1.83	11.83	377.1264	0.74	1	2.50	0.399	0.001	0.002	0.401	0.0033	1.807	0.013	tròn/pipe	0.6	0.439	6.22	5.61	4.86	4.22	
2120	2122	195	2120	1.4		1.4	10.00	2.20	12.20	374.1457	0.74	1	2.50	0.377	0.001	0.001	0.378	0.0037	1.505	0.013	tròn/pipe	0.6	0.499	6.22	5.61	4.97	4.25	
2121	2122	125	2121	0.6		0.6	10.00	1.81	11.81	377.2884	0.74	1	2.50	0.165	0.000	0.001	0.165	0.0093	1.171	0.013	tròn/pipe	0.6	0.300	6.76	5.61	5.62	4.46	
2122	2124	515	2122	7.2	3.4	10.6	12.20	3.15	15.35	350.456	0.74	1	2.50	2.744	0.005	0.011	2.755	0.0050	2.779	0.013	tròn/pipe	1.2	0.983	5.61	3.10	3.62	1.04	
2123	2124	170	2123	1.0		1.0	10.00	2.94	12.94	368.3189	0.74	1	2.50	0.275	0.000	0.001	0.276	0.0013	0.983	0.013	tròn/pipe	0.8	0.437	3.22	3.10	1.64	1.42	Existing
2124	2126	340	2124	2.4	28.7	31.1	15.35	2.51	17.87	333.6517	0.74	1	2.04	7.679	0.013	0.027	7.706	0.0017	2.299	0.013	hộp/box culvert	1×2.0×2.0	1.676	3.10	2.94	0.32	-0.25	
2125	2126	510	2125	3.6		3.6	10.00	6.94	16.94	339.6522	0.74	1	2.50	0.897	0.002	0.004	0.901	0.0013	1.249	0.013	tròn/pipe	1.0	0.864	3.22	2.94	1.64	0.98	Existing
2126	3146	150			34.7	34.7	17.87	1.00	18.86	327.4349	0.74	1	2.00	8.401	0.015	0.030	8.430	0.0021	2.557	0.013	hộp/box culvert	1×2.0×2.0	1.648	2.94	2.40	-0.25	-0.56	Flap gate
2127	2131	360	2127	2.9		2.9	10.00	1.52	11.52	379.7153	0.74	1	2.50	0.815	0.001	0.003	0.818	0.0120	4.026	0.013	tròn/pipe	0.6	0.405	8.10	3.80	6.30	1.98	Existing
2128	2131	360	2128	2.9		2.9	10.00	1.55	11.55	379.4914	0.74	1	2.50	0.809	0.001	0.003	0.812	0.0120	3.955	0.013	tròn/pipe	0.6	0.409	8.10	3.80	6.30	1.98	Existing
2129	2131	520	2129	3.0		3.0	10.00	2.19	12.19	374.2414	0.74	1	2.50	0.825	0.001	0.003	0.828	0.0125	4.035	0.013	tròn/pipe	0.6	0.409	10.10	3.80	8.30	1.80	Existing
2130	2131	520	2130	2.7		2.7	10.00	3.22	13.22	366.1525	0.74	1	2.50	0.721	0.001	0.003	0.724	0.0125	2.746	0.013	tròn/pipe	0.6	0.528	10.10	3.80	8.30	1.80	Existing
2131	3147	85			11.4	11.4	13.22	0.49	13.70	362.4533	0.74	1	2.50	3.063	0.005	0.012	3.075	0.0050	2.974	0.013	tròn/pipe	1.5	0.851	3.80	3.34	1.80	1.38	Flap gate
3147	BH1				11.4	11.4	13.70	0.58	14.28	358.1457	0.74	1		3.027			3.027									3.34		
3145	BH1				6.1	6.1	14.28	0.58	14.86	353.9419	0.74	1		1.598			1.598									3.67		
3144	BH1				7.5	7.5	14.86	0.58	15.44	349.8381	0.74	1		1.952			1.952									3.67		
3143	BH1				9.1	9.1	15.44	0.58	16.02	345.8309	0.74	1		2.326			2.326									2.40		
3142	BH1				5.1	5.1	16.02	0.58	16.60	341.9167	0.74	1		1.280			1.280									2.44		
3141	BH1				7.5	7.5	16.60	0.58	17.18	338.0923	0.74	1		1.866			1.866									2.44		
3140	BH1				9.8	9.8	17.18	0.58	17.76	334.3548	0.74	1		2.415			2.415									2.40		
3139	BH1				5.0	5.0	17.76	0.58	18.34	330.7011	0.74	1		1.224			1.224									2.40		
3138	BH1				2.2	2.2	18.34	0.58	18.91	327.1284	0.74	1		0.542			0.542									2.40		
BH1	BH2	1080		20.1	63.7	83.8	18.91	3.99	22.90	304.5062	0.74	1		18.876			18.876	0.0008	4.602	0.013	tròn/pipe	2xD2.3	2.211	2.44	2.40	-2.96	-3.87	Gate
Catchment No.2 Drainage system																											-0.33	
1201	1202	365	1201	8.1		8.1	10.00	2.12	12.12	374.803	0.74	1		2.247			2.247	0.0060	2.926	0.013	tròn/pipe	1.2	0.771	4.73	2.74	2.71	0.52	
1202	1206	320	1202	3.1	8.1	11.2	12.12	3.47	15.59	348.8223	0.74	1		2.878			2.878	0.0007	1.570	0.013	tròn/pipe	1.8	1.219	2.74	2.40	-0.08	-0.30	
1203	1204	365	1203	7.7		7.7	10.00	2.14	12.14	374.6316	0.74	1		2.140			2.140	0.0060	2.897	0.013	tròn/pipe	1.2	0.746	4.73	2.74	2.71	0.52	
1204	1206	335	1204	6.0	7.7	13.8	12.14	3.41	15.55	349.0647	0.74	1		3.554			3.554	0.0007	1.670	0.013	tròn/pipe	2.0	1.282	2.74	2.40	-0.08	-0.31	
1205	1206	155	1205	2.0		2.0	10.00	3.10	13.10	367.0494	0.74	1		0.546			0.546	0.0006	0.849	0.013	tròn/pipe	1.0	0.763	2.40	2.40	-0.28	-0.37	
1206	1211	375	1206	5.1	26.9	32.1	15.55	4.37	19.92	321.1092	0.74	1		7.616			7.616	0.0005	1.460	0.013	hộp/box culvert	1×2.5×2.5	2.087	2.40	2.40	-0.57	-0.76	=B×H
1207	1208	335	1207	9.7		9.7	10.00	1.91	11.91	376.4745	0.74	1		2.697			2.697	0.0058	2.974	0.013	tròn/pipe	1.2	0.897	4.27	2.40	2.25	0.31	
1208	1211	375	1208	5.2	9.7	14.9	11.91	4.04	15.96	346.262	0.74	1		3.823			3.823	0.0006	1.577	0.013	tròn/pipe	2.0	1.441	2.40	2.40	-0.29	-0.52	
1209	1210	335	1209	4.0		4.0	10.00	2.03	12.03	375.4983	0.74	1		1.120			1.120	0.0057	2.799	0.013	tròn/pipe	0.8	0.594	4.27	2.40	2.47	0.56	
1210	1211	395	1210	3.5	4.0	7.6	12.03	5.22	17.25	337.6078	0.74	1		1.891			1.891	0.0008	1.287	0.013	tròn/pipe	1.5	1.162	2.40	2.40	0.36	0.04	
1211	3201	105			54.5	54.5	17.25	1.07	18.32	330.8032	0.74	1		13.351			13.351	0.0005	1.673	0.013	hộp/box culvert	1×3.0×3.0	2.660	2.40	2.40	-0.76	-0.81	=B×H
1212	1213	335	1212	4.0		4.0	10.00	4.65	14.65	355.4642	0.74	1		1.052			1.052	0.0010	1.224	0.013	tròn/pipe	1.2	0.853	2.40	2.40	0.38	0.04	
1213	3202	280	1213	1.9	4.0	5.9	14.65	3.87	18.52	329.5717	0.74	1		1.439			1.439	0.0008	1.231	0.013	tròn/pipe	1.5	0.942	2.40	2.40	0.04	-0.18	
1214	1216	290	1214	4.6		4.6	10.00	3.51	13.51	363.8986	0.74	1		1.241			1.241	0.0013	1.403	0.013	tròn/pipe	1.2	0.876	2.40	2.40	0.60	0.22	
1215	1216	185	1215	2.6		2.6	10.00	2.55	12.55	371.3667	0.74	1		0.726			0.726	0.0013	1.233	0.013	tròn/pipe	1.0	0.701	2.40	2.40	0.82	0.58	
1216	3203	65	1216	0.2	7.3	7.5	13.51	0.77	14.29	358.121	0.74	1		1.985			1.985	0.0010	1.429	0.013	tròn/pipe	1.5	1.100	2.40	2.40	0.22	0.16	
1217	3204	225	1217	1.4		1.4	10.00	3.65	13.65	362.8337	0.74	1		0.368			0.368	0.0013	1.047	0.013	tròn/pipe	0.8	0.527	2.40	2.40	0.82	0.53	Existing
1218	3205	225	1218	1.1		1.1	10.00	3.87	13.87	361.2368	0.74	1		0.283			0.283	0.0013	0.989	0.013	tròn/pipe	0.8	0.444	2.40	2.40	0.82	0.53	Existing
1219	1222	345	1219	5.6		5.6	10.00	3.08	13.08	367.2253	0.74	1		1.514			1.514	0.0025	1.904	0.013	tròn/pipe	1.2	0.795	3.25	2.40	1.45	0.59	
1220	1222	250	1220	4.3		4.3	10.00	3.82	13.82	361.5894	0.74	1		1.151			1.151	0.0007	1.113	0.013	tròn/pipe	1.5	0.851	2.54	2.40	0.19	0.02	
1221	1222	250	1221	2.8		2.8	10.00	3.57	13.57	363.4738	0.74	1		0.753			0.753	0.0008	1.191	0.013	tròn/pipe	1.0	0.751	2.54	2.40	0.52	0.32	
1222	3206	490	1222	3.7	12.7	16.4	13.82	5.25	19.07	326.1736	0.74	1		3.956			3.956	0.0006	1.586	0.013	tròn/pipe	2.0	1.481	2.40	2.40	-0.29	-0.58	
1223	1226	325	1223	3.1		3.1	10.00	2.91	12.91	368.5625	0.74	1		0.851			0.851	0.0030	1.779	0.013	tròn/pipe	1.0	0.586	3.25	2.40	1.67	0.70	
1224	1226	190	1224	2.2		2.2	10.00	3.02	13.02	367.7164	0.74	1		0.601			0.601	0.0010	1.071	0.013	tròn/pipe	1.0	0.672	2.40	2.40	0.60	0.41	
1225	1226	190	1225	1.5		1.5	10.00	3.41	13.41	364.6947	0.74	1		0.402			0.402	0.0010	0.947	0.013	tròn/pipe	0.8	0.630	2.40	2.40	0.60	0.41	
1226	1229	405	1226	3.3	6.8	10.1	13.41	4.45	17.86	333.6863	0.74	1		2.499			2.499	0.0007	1.546	0.013	tròn/pipe	1.8	1.092	2.40	2.40	-0.09	-0.37	
1227	1229	300	1227	1.4		1.4	10.00	4.86	14.86	353.99	0.74	1		0.375			0.375	0.0013	1.050	0.013	tròn/pipe	0.8	0.534	2.40	2.40	0.82	0.43	Existing

Appendix 6-B Hydraulic Calculation Sheet of Drainage System

Pipe			Subcatchment area (ha)				$t_0 + t_1$	t_2	t	q	C	j	k_{cmax}	Discharge (m^3/s ec)				i_{pipe}	Velocity	n	Type	Diameter	Depth	Ground Level		Invert Level		Remarks
From	To	Length	Itself		Transfer	Total	min	min	min	l/sec.ha				Run-off	Domestic (ave)	Domestic (peak)	Q_{total}	(m/m)	(m/sec)			(m)	h (m)	From (m)	To (m)	From (m)	To (m)	
		m	name	Area																								
1228	1229	300	1228	3.2		3.2	10.00	4.06	14.06	359.7635	0.74	1		0.852			0.852	0.0013	1.255	0.013	tròn/pipe	1.0	0.807	2.40	2.40	0.82	0.43	Existing
1229	3207	75	1229	0.2	14.8	15.0	17.86	0.76	18.62	328.9172	0.74	1		3.644			3.644	0.0007	1.675	0.013	tròn/pipe	2.0	1.307	2.40	2.40	-0.37	-0.43	
1230	3208	380	1230	2.9		2.9	10.00	5.87	15.87	346.8646	0.74	1		0.755			0.755	0.0010	1.101	0.013	tròn/pipe	1.0	0.815	2.40	2.40	0.60	0.22	
1231	1234	295	1231	3.8		3.8	10.00	4.13	14.13	359.3003	0.74	1		1.005			1.005	0.0010	1.215	0.013	tròn/pipe	1.2	0.823	2.40	2.40	0.60	0.31	
1232	1234	200	1232	1.5		1.5	10.00	1.54	11.54	379.5208	0.74	1		0.430			0.430	0.0085	2.202	0.013	tròn/pipe	0.6	0.391	4.08	2.40	2.50	0.80	Existing
1233	1234	200	1233	1.1		1.1	10.00	1.68	11.68	378.3776	0.74	1		0.294			0.294	0.0085	2.021	0.013	tròn/pipe	0.6	0.307	4.08	2.40	2.50	0.80	Existing
1234	3209	100	1234	0.2	6.4	6.6	14.13	1.34	15.47	349.668	0.74	1		1.700			1.700	0.0008	1.270	0.013	tròn/pipe	1.5	1.063	2.40	2.40	0.11	0.02	
1235	1236	300	1235	4.0		4.0	10.00	1.73	11.73	378.0045	0.74	1		1.122			1.122	0.0100	2.952	0.013	tròn/pipe	0.8	0.566	8.61	5.65	7.03	4.03	
1239	1236	345	1239	3.8		3.8	10.00	2.13	12.13	374.727	0.74	1		1.045			1.045	0.0087	2.753	0.013	tròn/pipe	0.8	0.565	8.61	5.65	7.03	4.03	
1236	1237	295	1236	2.9	7.8	10.7	12.13	1.93	14.06	359.7991	0.74	1		2.838			2.838	0.0037	2.599	0.013	tròn/pipe	1.5	0.890	5.65	4.62	3.63	2.54	
1240	1237	305	1240	2.6		2.6	10.00	4.26	14.26	358.3354	0.74	1		0.676			0.676	0.0013	1.218	0.013	tròn/pipe	1.0	0.666	5.65	4.62	4.29	3.89	=B×H: Exi.
1237	1238	300	1237	3.5	13.2	16.7	14.26	2.36	16.62	341.7928	0.74	1		4.219			4.219	0.0013	2.161	0.013	tròn/pipe	1.8	1.290	4.62	4.20	2.24	1.85	
1241	1238	315	1241	3.1		3.1	10.00	3.80	13.80	361.7382	0.74	1		0.827			0.827	0.0017	1.409	0.013	tròn/pipe	1.0	0.700	4.62	4.20	3.26	2.72	=B×H: Exi.
1238	3210	310	1238	1.3	19.8	21.1	16.62	1.50	18.11	332.0972	0.74	1		5.173			5.173	0.0060	3.524	0.013	tròn/pipe	1.5	1.161	4.20	2.40	1.85	-0.01	
1242	3211	275	1242	1.2		1.2	10.00	2.18	12.18	374.2932	0.74	1		0.341			0.341	0.0090	2.140	0.013	tròn/pipe	0.6	0.330	4.81	2.40	3.45	0.98	=B×H: Exi.
1243	1246	255	1243	3.3		3.3	10.00	2.40	12.40	372.6017	0.74	1		0.921			0.921	0.0030	1.810	0.013	tròn/pipe	1.0	0.617	3.43	2.70	1.85	1.09	Existing
1244	1246	255	1244	3.3		3.3	10.00	2.40	12.40	372.552	0.74	1		0.910			0.910	0.0030	1.805	0.013	tròn/pipe	1.0	0.612	3.43	2.70	1.85	1.09	Existing
1245	1246	450	1245	4.1		4.1	10.00	5.60	15.60	348.7174	0.74	1		1.061			1.061	0.0013	1.366	0.013	tròn/pipe	1.2	0.779	3.24	2.70	1.44	0.86	
1246	3212	200	1246	0.9	10.8	11.7	15.60	1.94	17.55	335.7	0.74	1		2.904			2.904	0.0015	1.747	0.013	tròn/pipe	1.5	1.336	2.70	2.40	0.66	0.36	
1247	1248	450	1247	4.7		4.7	10.00	5.48	15.48	349.5978	0.74	1		1.206			1.206	0.0013	1.397	0.013	tròn/pipe	1.2	0.856	3.24	2.70	1.44	0.86	
1248	3213	200	1248	1.1	4.7	5.7	15.48	2.40	17.88	333.5983	0.74	1		1.410			1.410	0.0013	1.417	0.013	tròn/pipe	1.2	0.987	2.70	2.40	0.86	0.60	
1249	3214	540	1249	3.9		3.9	10.00	6.84	16.84	340.2901	0.74	1		0.969			0.969	0.0015	1.341	0.013	tròn/pipe	1.0	0.866	2.95	2.40	1.37	0.56	Existing
1250	3215	570	1250	3.9		3.9	10.00	7.21	17.21	337.8643	0.74	1		0.963			0.963	0.0015	1.343	0.013	tròn/pipe	1.0	0.857	2.95	2.40	1.37	0.52	Existing
1251	1254	395	1251	3.6		3.6	10.00	3.30	13.30	365.5013	0.74	1		0.963			0.963	0.0047	2.033	0.013	tròn/pipe	0.8	0.714	4.91	3.09	3.33	1.47	
1252	1254	405	1252	4.1		4.1	10.00	3.11	13.11	366.9541	0.74	1		1.113			1.113	0.0045	2.210	0.013	tròn/pipe	1.0	0.612	4.91	3.09	3.33	1.51	
1253	1254	420	1253	3.5		3.5	10.00	6.57	16.57	342.0909	0.74	1		0.896			0.896	0.0008	1.086	0.013	tròn/pipe	1.2	0.821	3.20	3.09	1.18	0.84	
1254	1255	325	1254	4.5	11.2	15.7	16.57	2.59	19.17	325.5942	0.74	1		3.788			3.788	0.0013	2.130	0.013	tròn/pipe	1.8	1.186	3.09	2.53	0.54	0.12	
1255	3216	350	1255	4.8	15.7	20.5	19.17	4.06	23.23	302.81	0.74	1		4.603			4.603	0.0007	1.465	0.013	hộp/box culvert	1×2.0×2.0	1.570	2.53	2.40	-0.18	-0.42	
1256	1259	445	1256	6.7		6.7	10.00	5.95	15.95	346.3406	0.74	1		1.720			1.720	0.0008	1.272	0.013	tròn/pipe	1.5	1.072	3.20	3.09	0.85	0.49	
1257	1259	380	1257	6.3		6.3	10.00	3.07	13.07	367.2635	0.74	1		1.723			1.723	0.0030	2.101	0.013	tròn/pipe	1.2	0.817	4.20	3.09	2.18	1.04	
1258	1259	405	1258	3.3		3.3	10.00	3.85	13.85	361.3633	0.74	1		0.872			0.872	0.0030	1.788	0.013	tròn/pipe	1.0	0.595	4.20	3.09	2.62	1.41	
1259	1260	330	1259	2.5	16.3	18.8	15.95	2.57	18.51	329.5868	0.74	1		4.593			4.593	0.0012	2.184	0.013	tròn/pipe	2.0	1.269	3.09	2.53	0.49	0.10	
1260	3217	335	1260	3.4	18.8	22.3	18.51	3.81	22.33	307.5787	0.74	1		5.067			5.067	0.0007	1.494	0.013	hộp/box culvert	1×2.0×2.0	1.696	2.53	2.40	-0.20	-0.44	
1283	3228	410	1283	2.4		2.4	10.00	5.50	15.50	349.4373	0.74	1		0.623			0.623	0.0015	1.268	0.013	tròn/pipe	1.0	0.600	2.98	2.40	1.40	0.79	Existing
1284	1287	355	1284	2.6		2.6	10.00	4.07	14.07	359.7324	0.74	1		0.695			0.695	0.0020	1.452	0.013	tròn/pipe	1.0	0.586	2.98	2.40	1.40	0.69	Existing
1285	1287	375	1285	3.3		3.3	10.00	4.63	14.63	355.6301	0.74	1		0.855			0.855	0.0010	1.377	0.013	tròn/pipe	1.0	0.738	2.40	2.40	0.60	0.23	
1286	1287	375	1286	3.3		3.3	10.00	4.63	14.63	355.6301	0.74	1		0.855			0.855	0.0010	1.377	0.013	tròn/pipe	1.0	0.738	2.40	2.40	0.60	0.23	
1287	3229	50			9.1	9.1	14.63	0.52	15.15	351.912	0.74	1		2.372			2.372	0.0008	1.639	0.013	tròn/pipe	1.8	0.998	2.40	2.40	0.02	-0.02	
1261	1263	340	1261	5.5		5.5	10.00	2.27	12.27	373.5746	0.74	1		1.515			1.515	0.0055	2.542	0.013	tròn/pipe	1.0	0.710	9.09	7.55	7.51	5.64	Existing
1262	1263	185	1262	1.2		1.2	10.00	1.36	11.36	381.0618	0.74	1		0.344			0.344	0.0110	2.315	0.013	tròn/pipe	0.6	0.312	9.53	7.55	8.17	6.14	=BxH: Exi.
1263	3218	50			6.7	6.7	12.27	0.26	12.54	371.4737	0.74	1		1.842			1.842	0.0090	3.224	0.013	tròn/pipe	1.0	0.683	7.55	6.97	5.64	5.19	Existing
1264	3219	270	1264	1.6		1.6	10.00	2.32	12.32	373.1955	0.74	1		0.439			0.439	0.0065	1.978	0.013	tròn/pipe	0.6	0.440	6.51	4.83	4.93	3.18	Existing
1265	3220	270	1265	2.7		2.7	10.00	1.99	11.99	375.8514	0.74	1		0.762			0.762	0.0065	2.305	0.013	tròn/pipe	0.8	0.500	6.51	4.83	4.93	3.18	Existing
1266	3221	320	1266	3.8		3.8	10.00	2.61	12.61	370.8661	0.74	1		1.043			1.043	0.0040	2.081	0.013	tròn/pipe	1.0	0.609	3.92	2.68	2.34	1.06	Existing
1267	3222	320	1267	1.8		1.8	10.00	3.14	13.14	366.7618	0.74	1		0.494			0.494	0.0040	1.733	0.013	tròn/pipe	0.8	0.442	3.92	2.68	2.34	1.06	Existing
1268	1271	375	1268	2.0		2.0	10.00	3.47	13.47	364.2589	0.74	1		0.526			0.526	0.0045	1.839	0.013	tròn/pipe	0.8	0.443	9.80	8.15	8.44	6.75	=B×H: Exi.
1270	1271	350	1270	2.4		2.4	10.00	2.96	12.96	368.179	0.74	1		0.654			0.654	0.0050	2.012	0.013	tròn/pipe	0.8	0.493	9.80	8.15	8.22	6.47	
1271	1272	385	1271	4.3	4.4	8.6	13.47	2.52	15.99	346.0294	0.74	1		2.205			2.205	0.0045	2.592	0.013	tròn/pipe	1.2	0.844	8.15	6.50	6.27	4.54	
1269	1272	365	1269	2.0		2.0	10.00	3.22	13.22	366.1623	0.74	1		0.542			0.542	0.0050	1.929	0.013	tròn/pipe	0.8	0.437	8.15	6.50	6.79	4.97	=B×H: Exi.
1272	1275	165	1272	1.2	10.6	11.8	15.99	0.63	16.62	341.7827	0.74	1		2.979			2.979	0.0165	4.467	0.013	tròn/pipe	1.0	0.792	6.50	3.66	4.34	1.62	
1273	1275	175	1273	0.9		0.9	10.00	1.69	11.69	378.3452	0.74	1		0.249			0.249	0.0165	1.764	0.013	tròn/pipe	0.6	0.300	6.50	3.66	5.14	2.25	Existing
1274	1275	310	1274	3.8		3.8	10.00	2.04	12.04	375.4614	0.74	1		1.050			1.050	0.0075	2.584	0.013	tròn/pipe	0.8	0.603	5.81	3.66	4.23	1.91	
1275	3223	335	1275	2.5	16.5	19.0	16.62	1.95	18.57	329.2367	0.74	1		4.627			4.627	0.0025	2.917	0.013	tròn/pipe	1.8	1.075	3.66	2.83	1.32	0.48	
1276	3224	650	1276	4.8		4.8	10.00	4.68	14.68	355.2884	0.74	1		1.257			1.257	0.0050	2.363	0.013	tròn/pipe	1.0	0.641	5.81	2.83	4.23	0.98	Existing
1277	3225	295	1277	1.8		1.8	10.00	1.82	11.82	377.2881	0.74	1		0.494			0.494	0.0140	2.763	0.013	tròn/pipe	0.6	0.363	6.50	2.40	5.14	1.01	=B×H: Exi.
1278	1281	245	1278	2.3		2.3	10.00	1.44	11.44	380.4017	0.74	1		0.636			0.636	0.0140	2.897	0.013	tròn/pipe	0.6	0.435	6.50	3.07	5.14	1.71	=B×H: Exi.
1279	1281	335	1279	5.4		5.4	10.00	1.45	11.45	380.26	0.74	1		1.508			1.508	0.0175	3.915	0.013	tròn/pipe	0.8	0.573	8.90	3.07	7.32	1.46	
1280	1281	345	1280	2.2		2.2	10.00	1.88	11.88	376.7877	0.74	1		0.619			0.619	0.0170	3.126	0.013	tròn/pipe	0.6	0.396	8.90	3.07	7.54	1.68	
1281	3226	65			9.8	9.8	11.88	0.26	12.13	374.7096	0.74	1		2.728			2.728	0.0105	4.314	0.013	tròn/pipe	1.0	0.751	3.07	2.40	1.26	0.57	
2203	3235	505	2203	4.0		4.0	10.00	3.55	13.55	363.6029	0.74	1		1.082			1.082	0.0065	2.416	0.013	tròn/pipe	0.8	0.667	5.66	2.40	4.30	1.02	=B×H: Exi.
2204	3236	510	2204	4.0		4.0	10.00	3.59	13.59	363.3375	0.74	1		1.081			1.081	0.0065	2.416	0.013	tròn/pipe	0.8	0.666	5.66	2.40	4.30	0.99	=B×H: Exi.
1282	3227	270	1282	4.7		4.7	10.00	3.70	13.70	362.4821	0.74	1		1.269			1.269	0.0010	1.240	0.013	tròn/pipe	1.2	1.018	2.51	2.40	0.49	0.22	
1291	3231	220	1291	1.0		1.0	10.00	2.40	12.40	372.5542	0.74	1		0.273			0.273	0.0045	1.558	0.013	tròn/pipe	0.6	0.357	3.61	2.68	2.36	1.37	
1292	3232	220	1292	2.9		2.9	10.00	1.87	11.87	376.8583	0.74	1		0.817			0.817	0.0045	2.003	0.013	tròn/pipe	0.8	0.605	3.61	2.68	2.03	1.04	

Appendix 6-B Hydraulic Calcilation Sheet of Drainage System

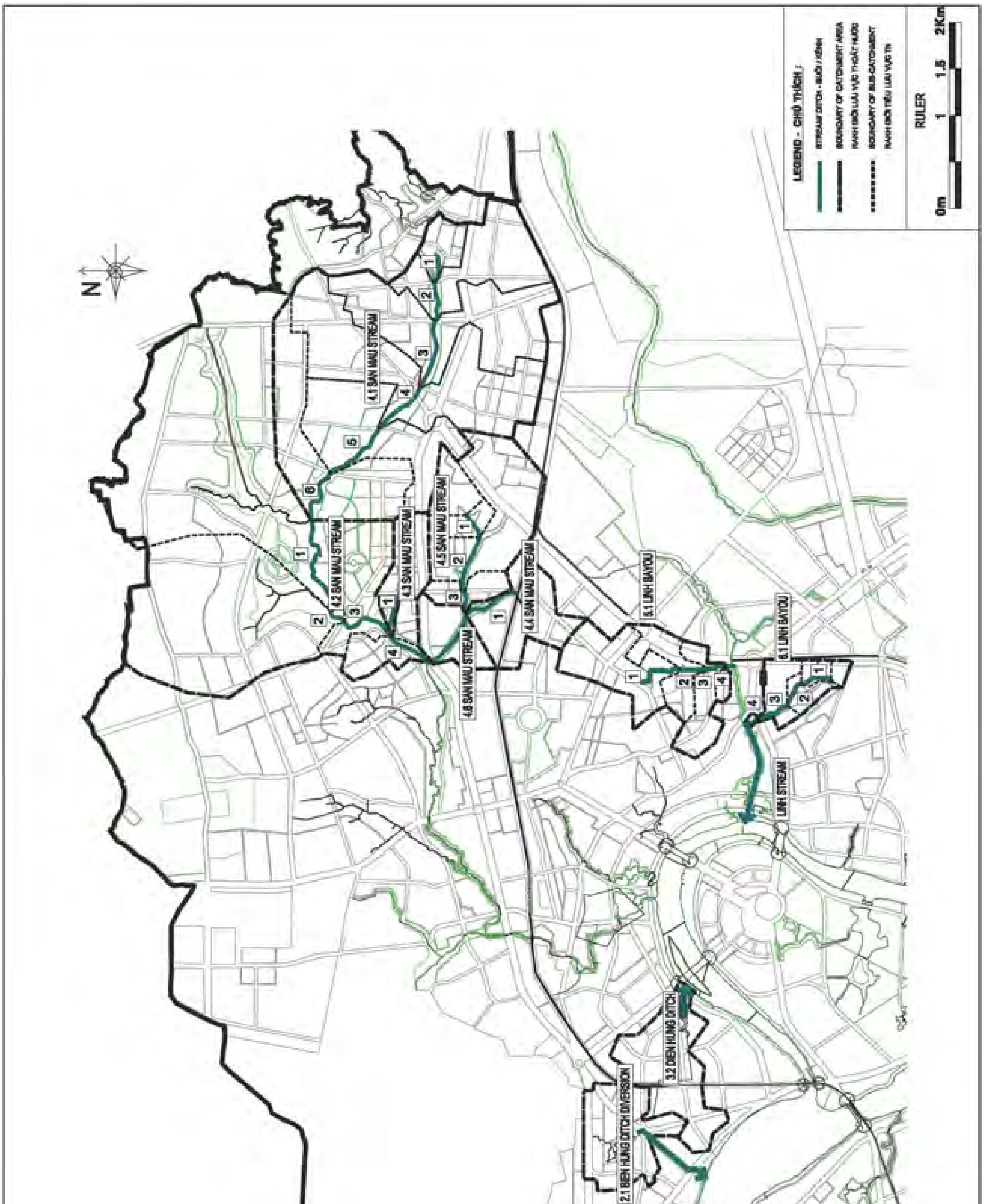
Pipe			Subcatchment area (ha)				$t_0 + t_1$	t_2	t	q	C	j	k_{cmax}	Discharge (m^3/s ec)				i_{pipe}	Velocity	n	Type	Diameter	Depth	Ground Level		Invert Level		Remarks
From	To	Length	Itself		Transfer	Total	min	min	min	l/sec.ha				Run-off	Domestic (ave)	Domestic (peak)	Q_{total}	(m/m)	(m/sec)			(m)	h (m)	From (m)	To (m)	From (m)	To (m)	
		m	name	Area																								
1288	1290	405	1288	1.8		1.8	10.00	6.38	16.38	343.3726	0.74	1		0.450			0.450	0.0013	1.079	0.013	tròn/pipe	0.8	0.618	2.58	2.40	1.00	0.47	
1289	1290	370	1289	2.3		2.3	10.00	5.32	15.32	350.708	0.74	1		0.587			0.587	0.0013	1.183	0.013	tròn/pipe	1.0	0.604	2.58	2.40	1.00	0.52	
1290	3230	15			4.0	4.0	16.38	0.19	16.57	342.1086	0.74	1		1.020			1.020	0.0013	1.355	0.013	tròn/pipe	1.2	0.758	2.40	2.40	0.47	0.45	
1293	1298	310	1293	5.0		5.0	10.00	2.64	12.64	370.6915	0.74	1		1.377			1.377	0.0033	1.999	0.013	tròn/pipe	1.0	0.819	3.36	2.40	1.56	0.54	
1294	1298	310	1294	2.0		2.0	10.00	3.23	13.23	366.0855	0.74	1		0.528			0.528	0.0033	1.633	0.013	tròn/pipe	0.8	0.491	3.36	2.40	1.78	0.76	
1295	1296	330	1295	3.2		3.2	10.00	2.42	12.42	372.423	0.74	1		0.874			0.874	0.0062	2.320	0.013	tròn/pipe	0.8	0.561	10.91	8.90	9.33	7.28	
1296	1297	310	1296	2.1	3.2	5.3	12.42	1.61	14.02	360.0705	0.74	1		1.402			1.402	0.0120	3.283	0.013	tròn/pipe	0.8	0.633	8.90	5.24	7.28	3.56	
1297	1298	250	1297	2.2	5.3	7.4	14.02	1.18	15.21	351.499	0.74	1		1.935			1.935	0.0115	3.595	0.013	tròn/pipe	1.0	0.648	5.24	2.40	3.36	0.49	
1298	3233	65			14.4	14.4	15.21	0.62	15.83	347.1637	0.74	1		3.702			3.702	0.0008	1.781	0.013	tròn/pipe	2.0	1.257	2.40	2.40	0.29	0.24	
1299	2201	330	1299	3.4		3.4	10.00	2.35	12.35	373.0026	0.74	1		0.936			0.936	0.0065	2.392	0.013	tròn/pipe	0.8	0.581	10.91	8.90	9.33	7.19	
2201	2202	310	2201	8.3	3.4	11.7	12.35	1.28	13.62	363.0679	0.74	1		3.133			3.133	0.0120	4.126	0.013	tròn/pipe	1.2	0.764	8.90	5.24	6.99	3.27	
2202	3234	325	2202	1.9	11.7	13.6	13.62	1.53	15.15	351.9022	0.74	1		3.531			3.531	0.0085	3.623	0.013	tròn/pipe	1.2	0.965	5.24	2.40	3.07	0.30	
2205	2208	340	2205	2.0		2.0	10.00	4.67	14.67	355.2959	0.74	1		0.536			0.536	0.0017	1.236	0.013	tròn/pipe	0.8	0.644	9.95	9.70	8.59	8.01	=B×H: Exi.
2207	2208	315	2207	7.9		7.9	10.00	4.17	14.17	358.9775	0.74	1		2.085			2.085	0.0008	1.284	0.013	tròn/pipe	1.5	1.297	9.95	9.70	7.93	7.68	
2208	2210	255	2208	6.3	9.9	16.2	14.67	2.02	16.69	341.3082	0.74	1		4.081			4.081	0.0013	2.151	0.013	tròn/pipe	1.8	1.257	9.70	9.37	7.38	7.05	
2206	2210	220	2206	1.1		1.1	10.00	2.46	12.46	372.0994	0.74	1		0.308			0.308	0.0017	1.521	0.013	tròn/pipe	0.6	0.404	9.70	9.37	8.34	7.97	=B×H: Exi.
2209	2210	420	2209	3.7		3.7	10.00	3.90	13.90	361.0128	0.74	1		0.978			0.978	0.0030	1.832	0.013	tròn/pipe	1.0	0.643	10.58	9.37	9.00	7.74	Existing
2210	3237	80			20.9	20.9	16.69	0.35	17.04	338.9987	0.74	1		5.253			5.253	0.0075	3.894	0.013	tròn/pipe	1.5	1.070	9.37	8.78	7.05	6.45	
2211	2212	345	2211	8.8		8.8	10.00	1.22	11.22	382.2309	0.74	1		2.495			2.495	0.0210	4.812	0.013	tròn/pipe	1.0	0.627	23.08	15.99	21.28	14.04	
2212	2216	330	2212	9.9	8.8	18.7	11.22	1.01	12.23	373.9156	0.74	1		5.180			5.180	0.0200	5.543	0.013	tròn/pipe	1.2	0.924	15.99	9.37	13.84	7.24	
2213	2214	345	2213	1.8		1.8	10.00	1.80	11.80	377.3789	0.74	1		0.508			0.508	0.0210	3.251	0.013	tròn/pipe	0.6	0.325	23.08	15.99	21.83	14.59	
2214	2216	330	2214	1.6	1.8	3.4	11.80	1.61	13.42	364.6233	0.74	1		0.915			0.915	0.0200	3.475	0.013	tròn/pipe	0.6	0.527	15.99	9.37	14.49	7.89	
2215	2216	420	2215	3.1		3.1	10.00	3.27	13.27	365.7237	0.74	1		0.839			0.839	0.0030	2.180	0.013	tròn/pipe	0.8	0.572	10.58	9.37	9.00	7.74	Existing
2216	3238	70			25.2	25.2	13.42	0.24	13.66	362.8163	0.74	1		6.768			6.768	0.0075	4.997	0.013	tròn/pipe	1.8	0.946	9.37	8.78	6.94	6.41	
2217	2218	480	2217	6.3		6.3	10.00	2.94	12.94	368.347	0.74	1		1.715			1.715	0.0065	2.780	0.013	tròn/pipe	1.0	0.733	10.52	7.41	8.72	5.60	
2218	3239	800	2218	7.0	6.3	13.3	12.94	4.33	17.27	337.519	0.74	1		3.324			3.324	0.0055	3.141	0.013	tròn/pipe	1.5	0.867	7.41	3.04	5.40	1.00	
2219	2220	480	2219	6.3		6.3	10.00	2.94	12.94	368.347	0.74	1		1.715			1.715	0.0065	2.780	0.013	tròn/pipe	1.0	0.733	10.52	7.41	8.72	5.60	
2220	3240	800	2220	7.0	6.3	13.3	12.94	4.33	17.27	337.519	0.74	1		3.324			3.324	0.0055	3.141	0.013	tròn/pipe	1.5	0.867	7.41	3.04	5.40	1.00	
2233	2234	355	2233	2.7		2.7	10.00	2.73	12.73	369.9665	0.74	1		0.728			0.728	0.0060	2.212	0.013	tròn/pipe	0.8	0.498	10.26	8.28	8.90	6.77	Existing
2241	2234	400	2241	1.8		1.8	10.00	3.35	13.35	365.1517	0.74	1		0.473			0.473	0.0050	2.030	0.013	tròn/pipe	0.6	0.461	10.26	8.28	8.90	6.90	Existing
2234	2237	365	2234	3.4	4.4	7.8	13.35	1.97	15.32	350.6815	0.74	1		2.024			2.024	0.0055	3.296	0.013	tròn/pipe	1.0	0.730	8.28	6.18	6.37	4.36	
2235	2237	245	2235	0.7		0.7	10.00	3.00	13.00	367.8326	0.74	1		0.196			0.196	0.0130	1.388	0.013	tròn/pipe	0.6	0.300	9.24	6.18	8.10	4.92	
2236	2237	245	2236	1.7		1.7	10.00	1.57	11.57	379.3399	0.74	1		0.474			0.474	0.0130	2.660	0.013	tròn/pipe	0.6	0.362	9.24	6.18	7.88	4.70	
2242	2237	370	2242	1.4		1.4	10.00	3.36	13.36	365.0637	0.74	1		0.384			0.384	0.0060	1.872	0.013	tròn/pipe	0.6	0.408	8.28	6.18	6.92	4.70	Existing
2237	2240	500	2237	4.2	11.6	15.9	15.32	3.27	18.60	329.0847	0.74	1		3.860			3.860	0.0020	2.596	0.013	tròn/pipe	1.8	1.020	6.18	5.27	3.86	2.86	
2238	2240	290	2238	1.7		1.7	10.00	2.27	12.27	373.6064	0.74	1		0.456			0.456	0.0080	2.172	0.013	tròn/pipe	0.6	0.417	7.47	5.27	6.11	3.79	
2239	2240	290	2239	1.3		1.3	10.00	2.37	12.37	372.7743	0.74	1		0.364			0.364	0.0080	2.077	0.013	tròn/pipe	0.6	0.357	7.47	5.27	6.22	3.90	
2240	3249	150	2240	0.8	18.8	19.6	18.60	0.69	19.28	324.8982	0.74	1		4.705			4.705	0.0070	3.715	0.013	tròn/pipe	1.5	1.011	5.27	4.21	2.86	1.81	
2243	2244	330	2243	1.7		1.7	10.00	3.06	13.06	367.3525	0.74	1		0.470			0.470	0.0055	1.831	0.013	tròn/pipe	0.6	0.512	6.18	4.43	4.60	2.79	Existing
2244	3250	270	2244	1.2	1.7	2.9	13.06	3.71	16.78	340.7418	0.74	1		0.739			0.739	0.0013	1.237	0.013	tròn/pipe	1.0	0.711	4.43	4.21	2.79	2.43	Existing
Catchment No.3 Drainage system																												
1301	1302	290	1301	2.9		2.9	10.00	3.72	13.72	362.3417	0.74	1		0.783			0.783	0.0015	1.325	0.013	tròn/pipe	1.0	0.704	30.88	30.47	29.30	28.87	
1302	1306	290	1302	3.8	2.9	6.7	13.72	2.16	15.88	346.7854	0.74	1		1.727			1.727	0.0045	2.281	0.013	tròn/pipe	1.0	0.922	30.47	29.17	28.67	27.36	
1303	1304	290	1303	6.1		6.1	10.00	2.75	12.75	369.7683	0.74	1		1.655			1.655	0.0015	1.790	0.013	tròn/pipe	1.2	0.914	30.88	30.47	28.86	28.43	
1304	1306	300	1304	5.3	6.1	11.3	12.75	1.80	14.55	356.1812	0.74	1		2.981			2.981	0.0045	2.835	0.013	tròn/pipe	1.5	0.862	30.47	29.17	28.43	27.08	
1305	1306	135	1305	1.3		1.3	10.00	1.33	11.33	381.3278	0.74	1		0.378			0.378	0.0050	1.730	0.013	tròn/pipe	0.6	0.433	29.78	29.17	28.20	27.53	Existing
1306	1310	240	1306	3.0	19.4	22.4	15.88	0.83	16.71	341.1941	0.74	1		5.656			5.656	0.0130	4.937	0.013	tròn/pipe	1.5	0.926	29.17	26.03	26.78	23.66	
1307	1310	355	1307	2.6		2.6	10.00	1.95	11.95	376.1615	0.74	1		0.710			0.710	0.0110	3.090	0.013	tròn/pipe	0.6	0.454	29.78	26.03	28.20	24.30	Existing
1308	1310	455	1308	7.7		7.7	10.00	2.29	12.29	373.42	0.74	1		2.136			2.136	0.0095	3.373	0.013	tròn/pipe	1.0	0.752	30.17	26.03	28.37	24.05	
1309	1310	455	1309	6.7		6.7	10.00	2.35	12.35	372.9964	0.74	1		1.844			1.844	0.0095	3.297	0.013	tròn/pipe	1.0	0.670	30.17	26.03	28.37	24.05	
1310	1312	250	1310	1.5	39.4	40.8	16.71	0.61	17.32	337.1922	0.74	1		10.190			10.190	0.0176	6.982	0.013	tròn/pipe	1.5	1.155	26.03	21.67	23.66	19.26	
1311	1312	475	1311	12.7		12.7	10.00	3.29	13.29	365.5841	0.74	1		3.425			3.425	0.0018	2.452	0.013	tròn/pipe	1.8	0.969	22.50	21.67	20.15	19.30	
1318	1312	235	1318	3.1		3.1	10.00	1.18	11.18	382.5809	0.74	1		0.886			0.886	0.0190	3.394	0.013	tròn/pipe	0.6	0.522	26.03	21.67	24.45	19.99	Existing
1312	1317	360	1312	2.2	56.6	58.8	17.32	0.74	18.05	332.4851	0.74	1		14.462			14.462	0.0200	8.329	0.013	tròn/pipe	1.8	1.161	21.67	14.50	18.96	11.76	
1313	1314	350	1313	3.9		3.9	10.00	2.07	12.07	375.2051	0.74	1		1.083			1.083	0.0095	2.873	0.013	tròn/pipe	0.8	0.561	19.69	16.41	18.33	15.01	=B×H: Exi.
1314	1317	360	1314	3.9	3.9	7.8	12.07	2.20	14.27	358.2357	0.74	1		2.078			2.078	0.0055	2.782	0.013	tròn/pipe	1.2	0.753	16.41	14.50	14.61	12.63	
1315	1316	350	1315	7.8		7.8	10.00	1.76	11.76	377.7388	0.74	1		2.180			2.180	0.0095	3.381	0.013	tròn/pipe	1.0	0.765	19.69	16.41	17.89	14.57	
1316	1317	375	1316	4.6	7.8	12.4	11.76	2.08	13.84	361.4567	0.74	1		3.303			3.303	0.0052	3.069	0.013	tròn/pipe	1.5	0.879	16.41	14.50	14.37	12.42	
1319	1317	355	1319	4.3		4.3	10.00	1.52	11.52	379.7567	0.74	1		1.194			1.194	0.0205	3.983	0.013	tròn/pipe	0.8	0.461	21.67	14.50	20.09	12.81	Existing
1317	3301	490	1317	3.3	83.2	86.5	18.05	1.37	19.42	324.0474	0.74	1		20.745			20.745	0.0115	6.068	0.013	hộp/box culvert	1×2.0×2.0	1.709	14.50	8.85	11.56	5.92	=B×H
1320	3302	420	1320	5.7		5.7	10.00	2.01	12.01	375.6706	0.74	1		1.590			1.590	0.0140	3.546	0.013	tròn/pipe	0.8	0.668	14.50	8.85	12.92	7.04	Existing
1330	1332	235	1330	2.4		2.4	10.00	1.33	11.33	381.3339	0.74	1		0.683			0.683	0.0150	3.013	0.013	tròn/pipe	0.6	0.448	31.00	27.62	29.64	26.12	
1331	1332	210	1331	2.3		2.3	10.00	1.14	11.14	382.8692	0.74	1		0.660			0.660	0.0165	3.123	0.013	tròn/pipe	0.6	0.420	31.00	27.62	29.64	26.18	
1332	1334	245	1332	3.1	4.8	7.8	11.33	0.75	12.08	375.1271	0.74	1		2.176			2.176	0.0345	5.519	0.013	tròn/pipe	0.8	0.586	27.62	19.19	25.92	17.46	

Appendix 6-B Hydraulic Calcilation Sheet of Drainage System

Pipe			Subcatchment area (ha)				$t_0 + t_1$	t_2	t	q	C	j	k_{cmax}	Discharge (m^3/s ec)										Ground Level		Invert Level		
From	To	Length	Itself		Transfer	Total	min	min	min	l/sec.ha				Run-off	Domestic (ave)	Domestic (peak)	Q_{total}	i_{pipe} (m/m)	Velocity (m/sec)	n	Type	Diameter (m)	Depth h (m)	From (m)	To (m)	From (m)	To (m)	Remarks
		m	name	Area																								
1333	1334	265	1333	4.1		4.1	10.00	1.04	11.04	383.773	0.74	1		1.176			1.176	0.0320	4.349	0.013	tròn/pipe	0.6	0.547	27.62	19.19	26.04	17.56	
1334	3304	40			12.0	12.0	12.08	0.36	12.45	372.2056	0.74	1		3.300			3.300	0.0010	1.867	0.013	tròn/pipe	1.8	1.180	19.19	19.19	17.26	17.22	
1335	1338	380	1335	6.6		6.6	10.00	1.38	11.38	380.9216	0.74	1		1.852			1.852	0.0250	4.698	0.013	tròn/pipe	0.8	0.586	26.81	17.36	25.23	15.73	
1336	1338	380	1336	6.7		6.7	10.00	2.57	12.57	371.2007	0.74	1		1.843			1.843	0.0053	2.512	0.013	tròn/pipe	1.0	0.883	19.30	17.36	17.50	15.49	
1337	1338	380	1337	4.4		4.4	10.00	2.66	12.66	370.4899	0.74	1		1.193			1.193	0.0055	2.427	0.013	tròn/pipe	1.0	0.599	19.30	17.36	17.94	15.85	=B×H: Exi.
1338	1342	425	1338	3.6	17.6	21.2	12.66	1.27	13.93	360.7609	0.74	1		5.665			5.665	0.0210	5.694	0.013	tròn/pipe	1.2	0.987	17.36	8.48	15.29	6.36	
1339	1340	395	1339	6.3		6.3	10.00	1.46	11.46	380.1949	0.74	1		1.784			1.784	0.0240	4.592	0.013	tròn/pipe	0.8	0.577	26.81	17.36	25.23	15.75	
1340	1342	405	1340	3.7	6.3	10.0	11.46	1.38	12.84	369.0796	0.74	1		2.739			2.739	0.0220	4.995	0.013	tròn/pipe	1.0	0.658	17.36	8.48	15.55	6.64	
1341	1342	155	1341	1.9		1.9	10.00	1.08	11.08	383.4158	0.74	1		0.531			0.531	0.0100	2.444	0.013	tròn/pipe	0.6	0.430	10.02	8.48	8.66	7.11	Existing
1342	3305	260	1342	2.7	33.1	35.8	13.93	0.67	14.60	355.8337	0.74	1		9.429			9.429	0.0130	6.600	0.013	tròn/pipe	1.8	0.987	8.48	5.12	6.06	2.68	
1343	3306	430	1343	3.4		3.4	10.00	2.38	12.38	372.6972	0.74	1		0.940			0.940	0.0120	3.067	0.013	tròn/pipe	0.8	0.469	10.02	5.12	8.66	3.50	Existing
1348	3311	510	1348	5.4		5.4	10.00	4.61	14.61	355.7666	0.74	1		1.422			1.422	0.0025	1.881	0.013	tròn/pipe	1.2	0.761	4.04	2.84	2.24	0.97	
1349	3312	500	1349	4.6		4.6	10.00	4.89	14.89	353.7756	0.74	1		1.207			1.207	0.0025	1.740	0.013	tròn/pipe	1.0	0.826	4.04	2.84	2.24	0.99	
1344	3307	130	1344	1.0		1.0	10.00	1.09	11.09	383.3211	0.74	1		0.286			0.286	0.0100	2.029	0.013	tròn/pipe	0.6	0.300	3.81	2.57	2.45	1.15	=B×H: Exi.
1345	3308	130	1345	1.7		1.7	10.00	0.92	10.92	384.7716	0.74	1		0.484			0.484	0.0100	2.406	0.013	tròn/pipe	0.6	0.402	3.81	2.57	2.45	1.15	=B×H: Exi.
1346	3309	310	1346	3.1		3.1	10.00	2.23	12.23	373.9114	0.74	1		0.863			0.863	0.0065	2.362	0.013	tròn/pipe	0.8	0.546	4.99	3.12	3.63	1.62	=B×H: Exi.
1347	3310	300	1347	1.9		1.9	10.00	2.58	12.58	371.1245	0.74	1		0.525			0.525	0.0065	1.976	0.013	tròn/pipe	0.6	0.533	4.99	3.12	3.63	1.68	=B×H: Exi.
1350	3313	410	1350	4.2		4.2	10.00	3.30	13.30	365.5435	0.74	1		1.123			1.123	0.0040	2.113	0.013	tròn/pipe	1.0	0.640	3.86	2.40	2.28	0.64	
1351	3314	410	1351	4.2		4.2	10.00	3.30	13.30	365.5435	0.74	1		1.123			1.123	0.0040	2.113	0.013	tròn/pipe	1.0	0.640	3.86	2.40	2.28	0.64	
1353	3315	270	1353	2.5		2.5	10.00	3.38	13.38	364.897	0.74	1		0.680			0.680	0.0017	1.357	0.013	tròn/pipe	1.0	0.610	8.17	7.93	6.59	6.13	
1352	1355	375	1352	3.6		3.6	10.00	4.45	14.45	356.9578	0.74	1		0.956			0.956	0.0017	1.434	0.013	tròn/pipe	1.0	0.792	8.77	8.17	6.97	6.33	
1354	1355	345	1354	5.0		5.0	10.00	3.45	13.45	364.3726	0.74	1		1.337			1.337	0.0020	1.699	0.013	tròn/pipe	1.2	0.788	8.77	8.17	6.97	6.28	
1355	3316	330	1355	3.6	8.6	12.2	14.45	3.03	17.48	336.1452	0.74	1		3.025			3.025	0.0010	1.850	0.013	tròn/pipe	1.8	1.103	8.17	7.93	5.78	5.45	
1358	1359	515	1358	10.9		10.9	10.00	2.77	12.77	369.6528	0.74	1		2.976			2.976	0.0050	3.163	0.013	tròn/pipe	1.2	0.931	18.35	15.85	16.33	13.76	
1359	3319	470	1359	2.7	10.9	13.5	12.77	1.70	14.47	356.7748	0.74	1		3.575			3.575	0.0155	4.693	0.013	tròn/pipe	1.2	0.766	15.85	8.61	13.76	6.47	
1360	1361	500	1360	5.9		5.9	10.00	3.46	13.46	364.2768	0.74	1		1.590			1.590	0.0050	2.454	0.013	tròn/pipe	1.0	0.769	18.35	15.85	16.55	14.05	
1361	3320	460	1361	6.7	5.9	12.6	13.46	1.54	15.01	352.9187	0.74	1		3.293			3.293	0.0160	5.073	0.013	tròn/pipe	1.0	0.770	15.85	8.61	14.05	6.69	

Appendix 6-C

Layout Plan of Stream and Ditch


LEGEND - CHÚ THÍCH :
RULER
0m
1
1.5
2Km
N
4.1 SAN MAU STREAM
4.2 SAN MAU STREAM
4.3 SAN MAU STREAM
4.5 SAN MAU STREAM
4.4 SAN MAU STREAM
4.6 SAN MAU STREAM
5.1 LINH BAYOU
6.1 LINH BAYOU
LINH STREAM
3.2 BIEN HUNG DITCH
2.1 BIEN HUNG DITCH DIVERSION

Appendix 6-D

Hydraulic Calculation Sheet of Stream and Ditch

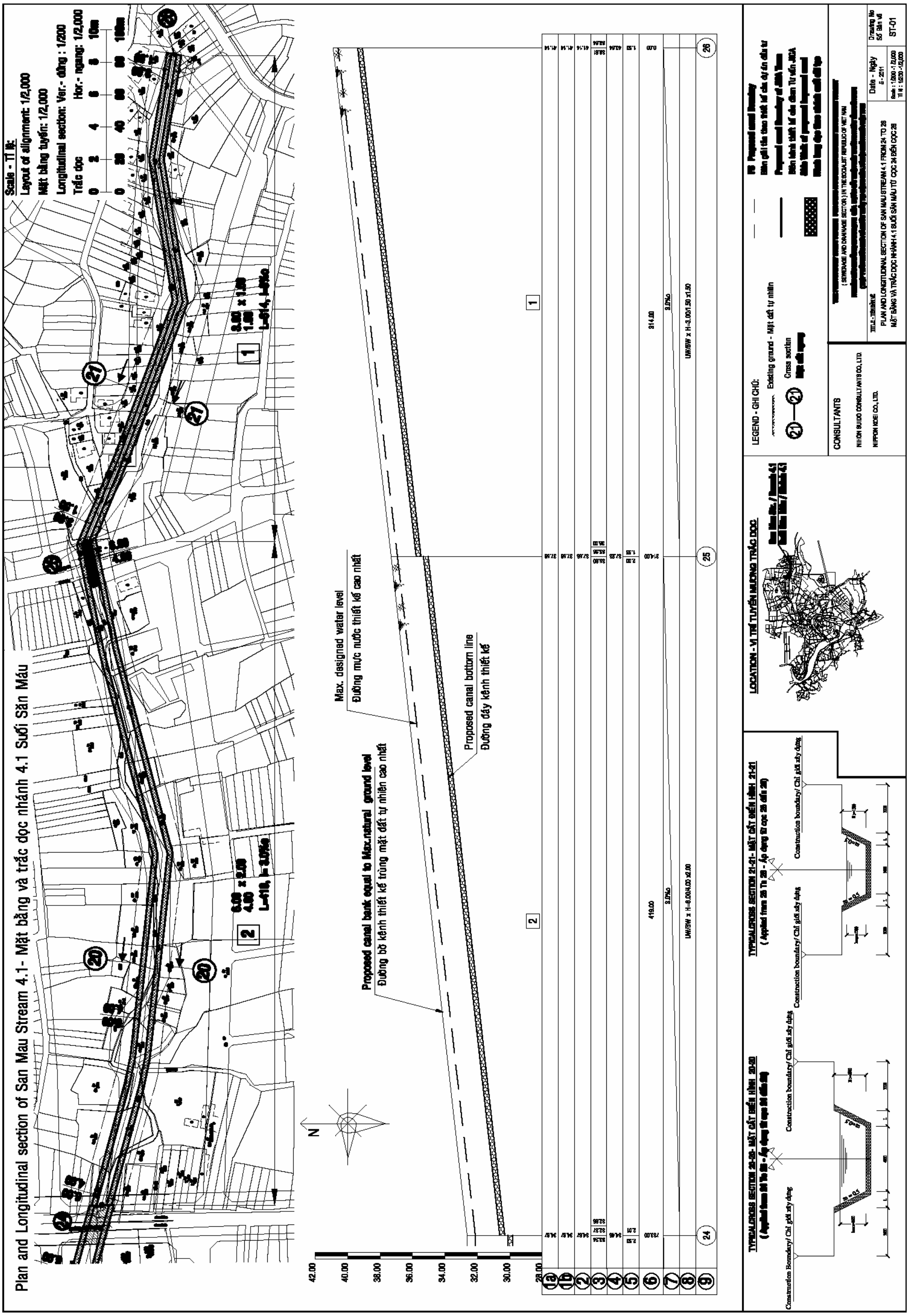
Appendix 6-D Hydraulic Calculation Sheet of Stream and Ditch

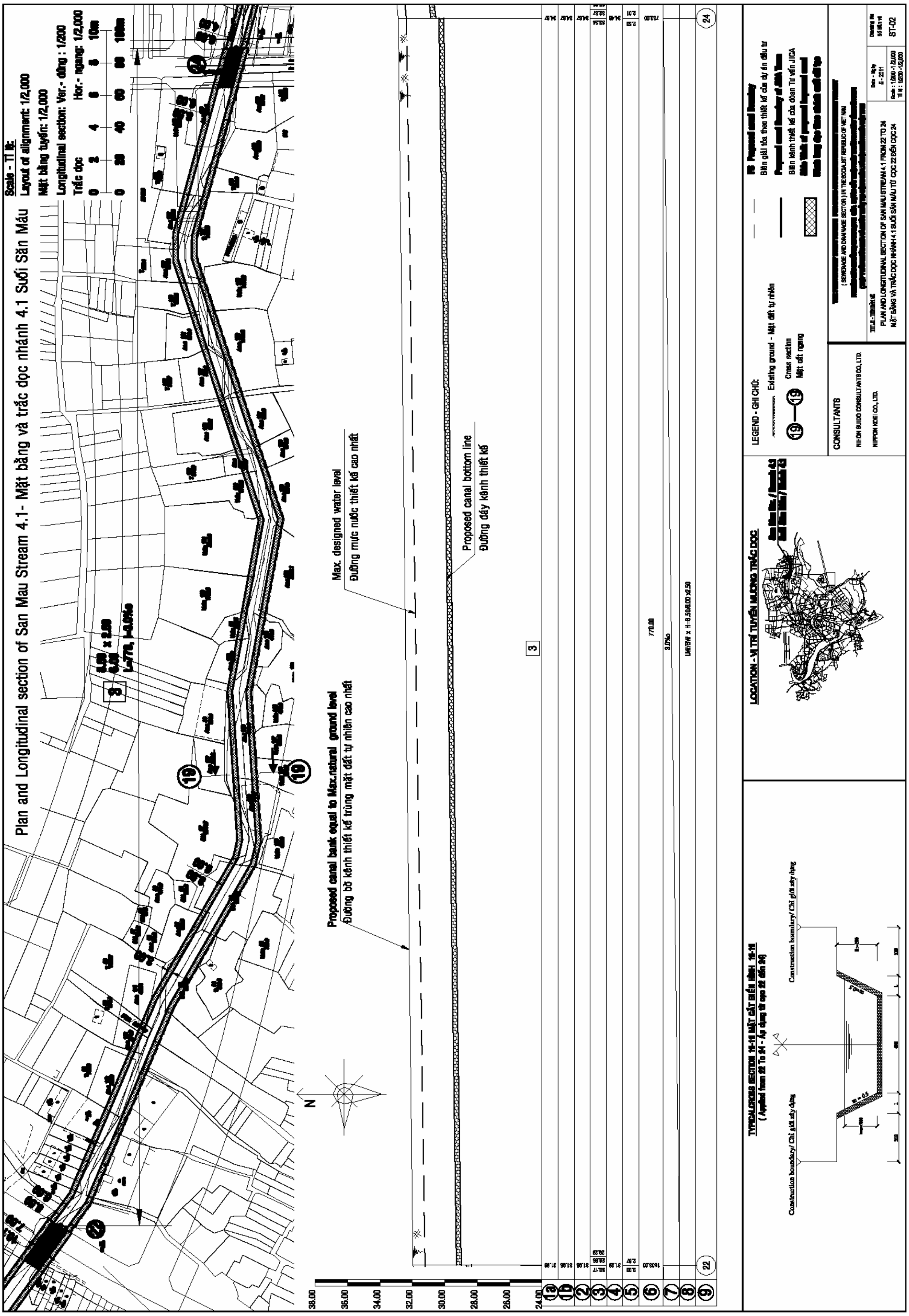
Sub-area	Đoạn cống/Stream No.		Chiều dài Length m	D.tích l.vực/Subcatchment area (ha) Bản thân / Itself Tên/name	Dtích/Area	C.qua Transfer	Tổng cộng Total	$t_0 + t_1$ phút/min	t_2 phút/min	t phút/min	q (l/s.ha)	C	ϕ	$Q_{nước\ mưa}$ Discharge (m^3/s)	Upper width (m)	Bottom width (m)	Height (m)	Slope (1/1,000)	Velocity (m/s)	Flow rate (m^3/s)
			700					10.00	9.72	19.72				m=	0.5					
4.1 San Mau	1		314		6.3	18.0	24.3		1.88	60.00	223.11473	0.7	1.00	3.795	3.00	1.50	1.50	3.0	2.79	7.032
Stream	2		419		12.4	80.6	117.3		1.77	61.77	219.113935	0.7	1.00	17.991	6.00	4.00	2.00	3.0	3.95	30.316
	3		770		19.9	131.8	269.0		2.70	64.47	213.277547	0.7	1.00	40.160	8.50	6.00	2.50	3.0	4.75	66.470
	4		624		18.1	180.7	467.8		2.09	66.56	208.985282	0.66	0.94	60.856	10.70	7.50	3.20	2.4	4.98	112.017
	5		852		22.1	100.1	590.0		2.85	69.41	203.403006	0.63	0.93	70.636	10.70	7.50	3.20	2.4	4.98	112.017
	6		676		94.3	36.1	720.4		2.26	71.67	199.18177	0.59	0.93	78.362	11.00	7.50	3.50	2.2	4.98	124.041
From 4.1			3400	(Branch stream length)			720.4	10.00	56.67	66.67				m=	0.75					
4.2 San Mau	1		1155		485.0		1205.4		3.99	70.66	201.046009	0.52	0.90	113.196	12.75	7.50	3.50	2.0	4.82	129.576
Stream	2		304		287.8		1493.2		0.98	71.64	199.230739	0.52	0.88	136.821	13.50	7.50	4.00	2.0	5.14	162.983
	3-1				3.7	35.9	1532.8			71.64	199.230739	0.52	0.88	140.165	13.50	7.50	4.00	2.0	5.14	162.983
	3-2		472		5.9	2.5	1541.2		1.53	73.17	196.477999	0.52	0.88	138.926	13.50	7.50	4.00	2.0	5.14	162.983
	4		553		9.1	72.3	1622.6		1.79	74.97	193.350517	0.52	0.88	143.346	13.50	7.50	4.00	2.0	5.14	162.983
	Down stream of San Mau Bridge						1920.3				193.350517	0.52	0.87	167.235	15.50	7.50	4.00	2.0	5.35	198.130
														m=	0.25					
4.3 San Mau	1		398		12.7	29.8	42.5	10.00	1.69	11.69	452.63351	0.59	1.00	11.350	2.90	2.00	1.80	5.0	3.92	13.325
Stream																				
			760					10.00	10.56	20.56				m=	0.25					
4.4 San Mau	1		615		38.1	40.8	78.9		2.35	22.91	364.298532	0.7	1.0	20.120	3.50	2.50	2.00	5.0	4.35	20.200
Stream																				
			860					10.00	11.94	21.94	370.490682			m=	0.25					
4.5 San Mau	1		324		18.1	25.6	43.7		1.25	23.19	362.534602	0.7	1.00	11.090	2.75	2.00	1.50	7.0	4.33	11.953
Stream	2		744		35.6	73.7	153.0		2.56	25.75	347.230306	0.7	1.00	37.188	5.25	4.00	2.50	4.0	4.84	43.534
	3		247		1.8	21.7	176.5		0.85	26.61	342.438252	0.7	1.00	42.308	5.25	4.00	2.50	4.0	4.84	43.534
From 4.4, 4.5										26.61				m=	0.75					
4.6 San Mau	1-1				29.0	255.4	284.4			26.61	342.438252	0.7	1.00	68.173	9.75	6.00	2.50	3.0	4.81	72.164
Stream	1-2		727			13.3	297.7		2.52	29.12	329.019999	0.7	1.00	68.564	9.75	6.00	2.50	3.0	4.81	72.164
			955					10.00	13.26	23.26				m=	0.75					
5.1	1-1					46.7	46.7			23.26	362.082311	0.7	1.0	11.836	5.00	2.00	2.00	3.0	3.52	18.021
Linh Bayou	1-2		478		9.4	12.0	68.1		2.26	25.53	348.534948	0.7	1.0	16.615	5.00	2.00	2.00	3.0	3.52	18.021
	2		276		3.1	24.8	96.0		1.21	26.74	341.720379	0.7	1.0	22.964	6.00	3.00	2.00	3.0	3.81	25.585
	3		223		2.0	31.8	129.8		0.91	27.64	336.770545	0.7	1.0	30.599	6.75	3.00	2.50	2.8	4.09	36.796
	4		83		0.5	5.1	135.4		0.34	27.98	334.965594	0.7	1.0	31.748	6.75	3.00	2.50	2.8	4.09	36.796
			250				4.7	10.00	3.47	13.47				m=	0.75					
6.1	1		401		7.9		12.6		2.52	15.99	414.015079	0.7	1.00	3.652	3.75	1.50	1.50	2.5	2.65	7.639
Linh Bayou	2		205		12.4		25.0		1.29	17.28	403.727155	0.7	1.00	7.065	3.75	1.50	1.50	2.5	2.65	7.639
	3		379		21.8		46.8		1.98	19.26	388.907558	0.7	1.00	12.741	5.20	2.50	1.80	2.5	3.19	16.458
	4		169		1.3	7.3	55.4		0.88	20.14	382.653086	0.7	1.00	14.839	5.20	2.50	1.80	2.5	3.19	16.458

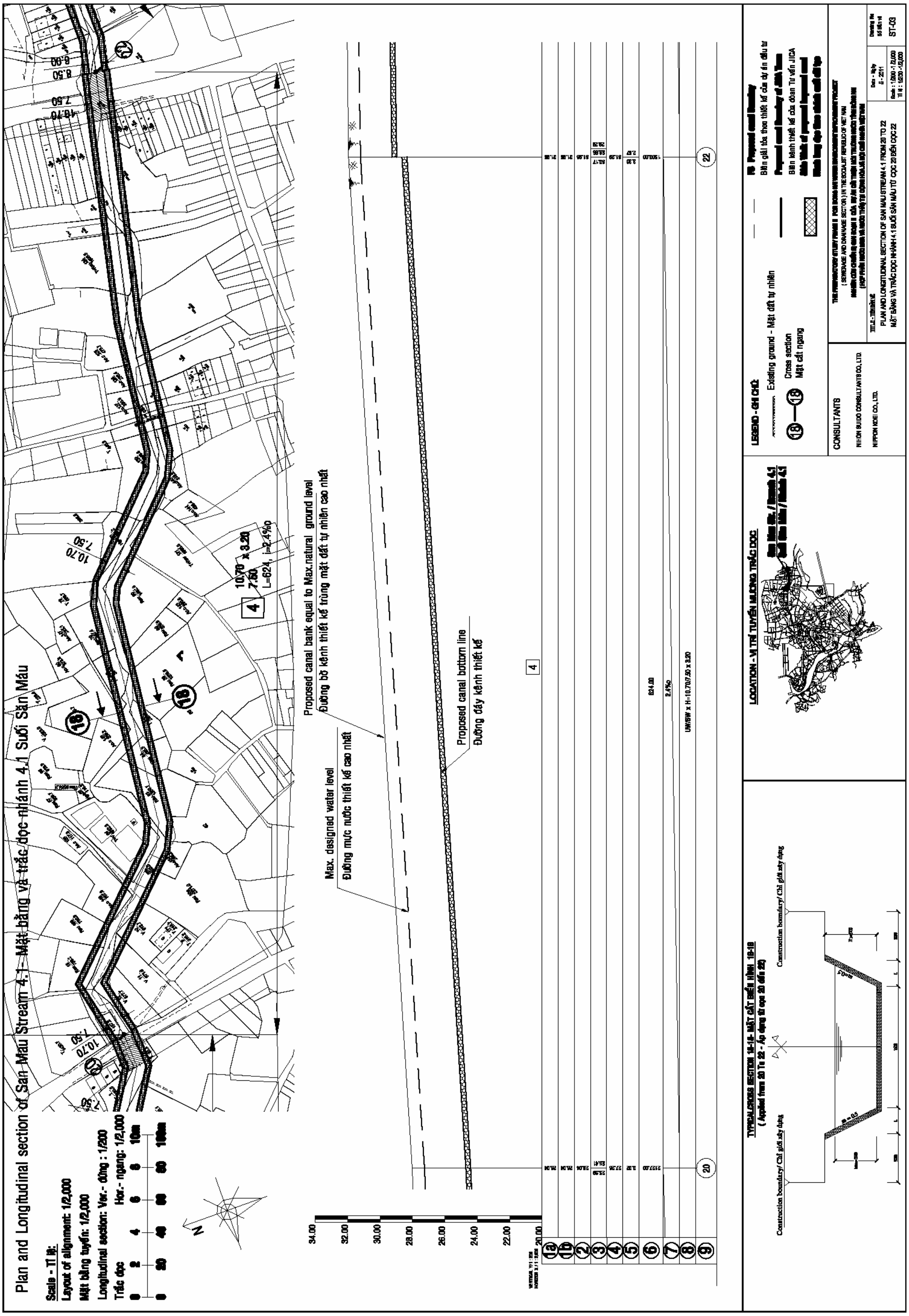
Note: Hydraulic Calculation of "2.1 Bien Hung Ditch Diversion" id shown in the Appendix 6-B.

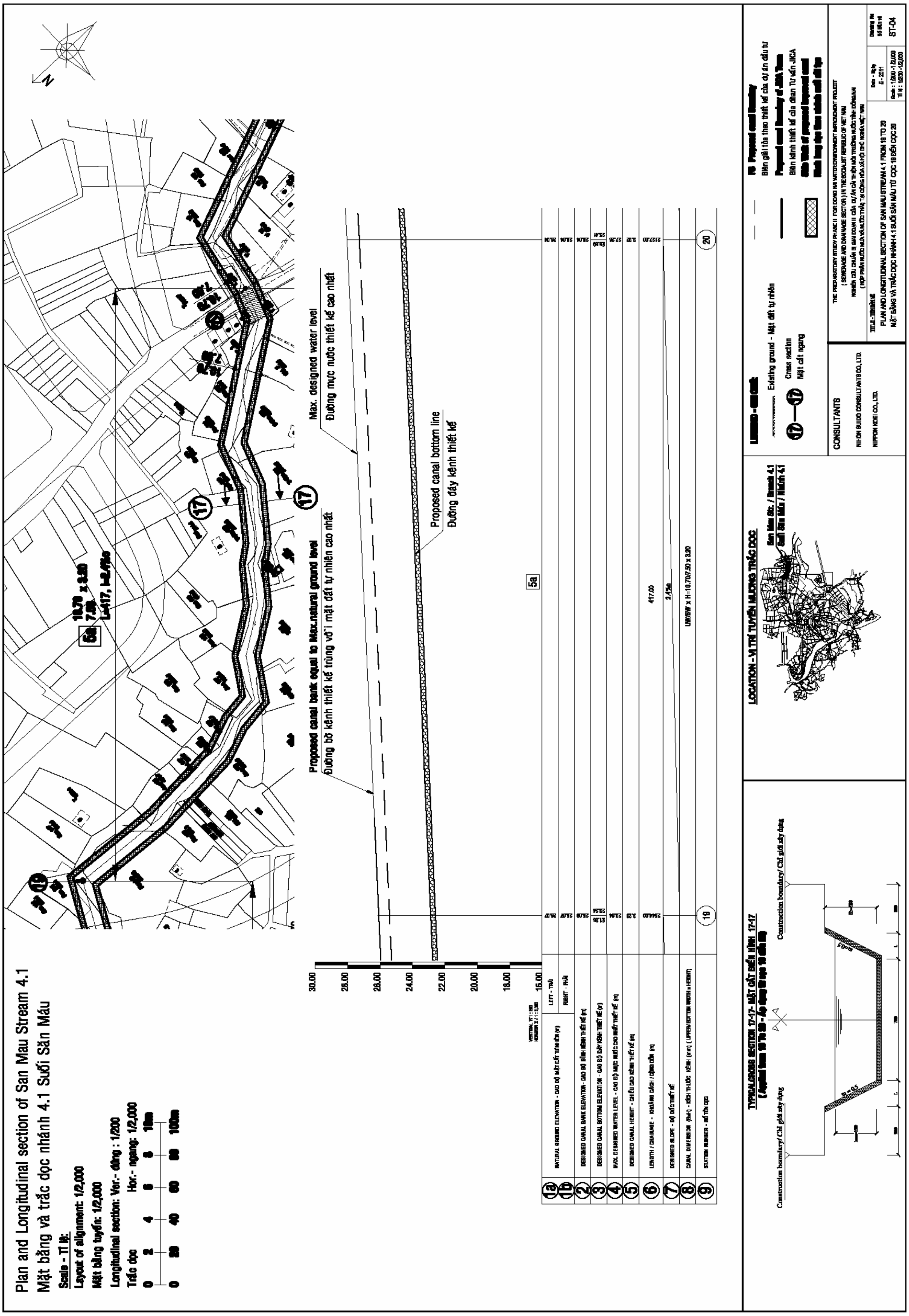
Appendix 6-E

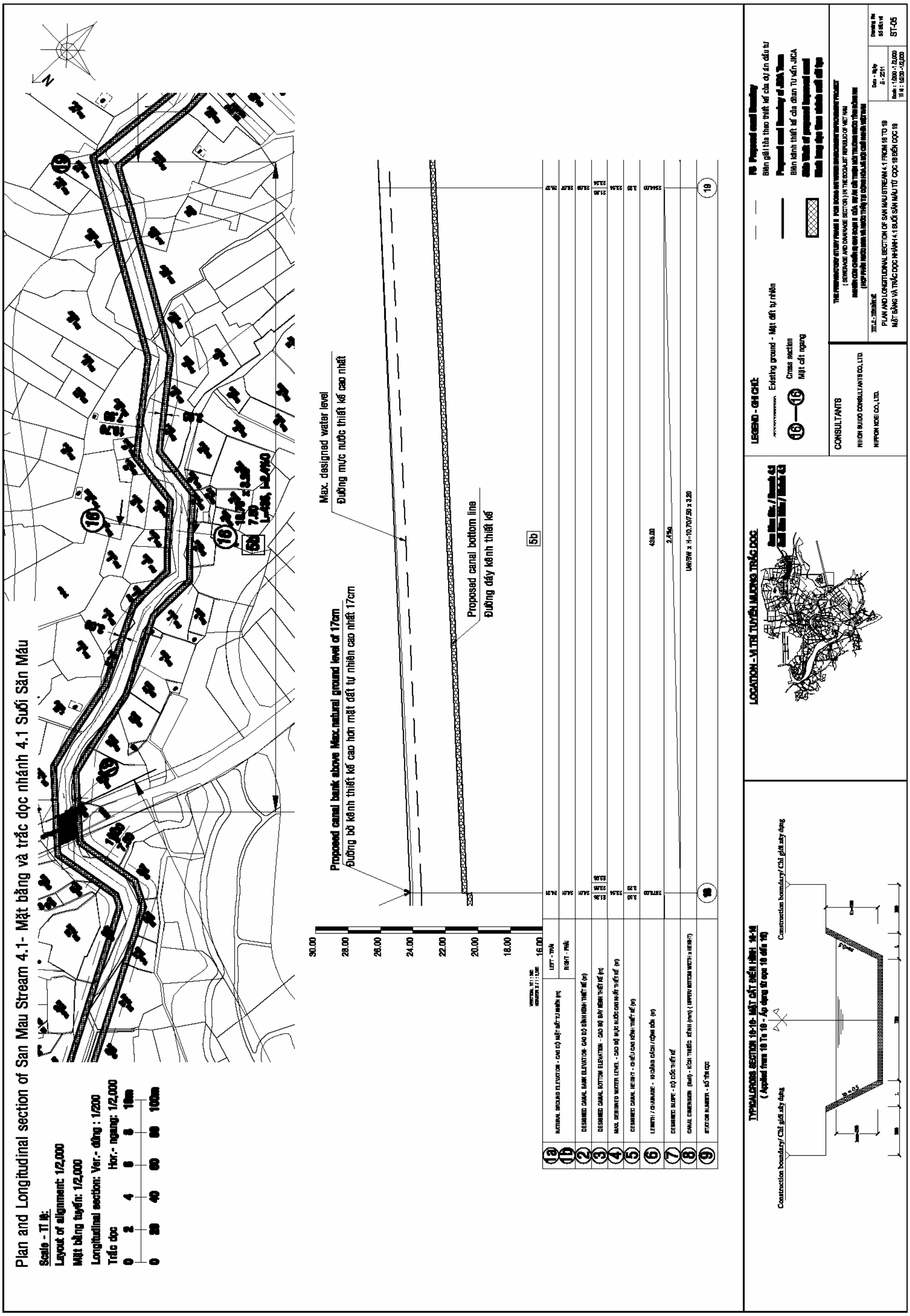
Detail Drawing of Stream and Ditch

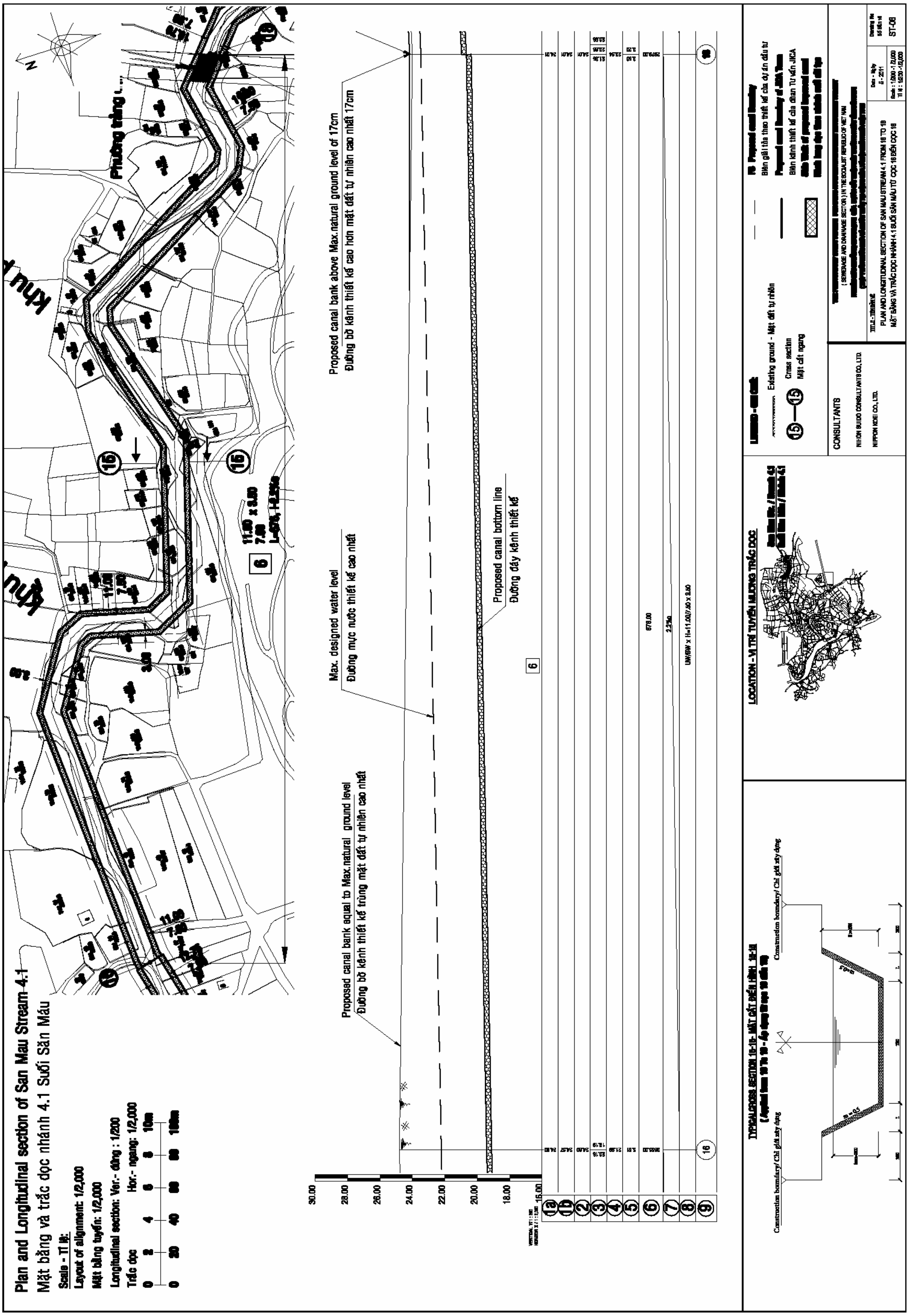

Plan and Longitudinal section of San Mau Stream 4.1- Mặt bằng và trắc dọc nhánh 4.1 Suối Săn Máu
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
LEGEND - GHI CHÚ:
Existing ground - Mặt đất tự nhiên
Cross section
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
CONSULTANTS
NIHON SUIDO CONSULTANTS CO., LTD
NIPPON KOEI CO., LTD.
PLAN AND LONGITUDINAL SECTION OF SAN MAU STREAM 4.1 FROM 24 TO 28
MẶT BẰNG VÀ TRẮC DỌC NHÁNH 4.1 SUỐI SĂN MÁU TỪ CỌC 24 ĐẾN CỌC 28
ST-01

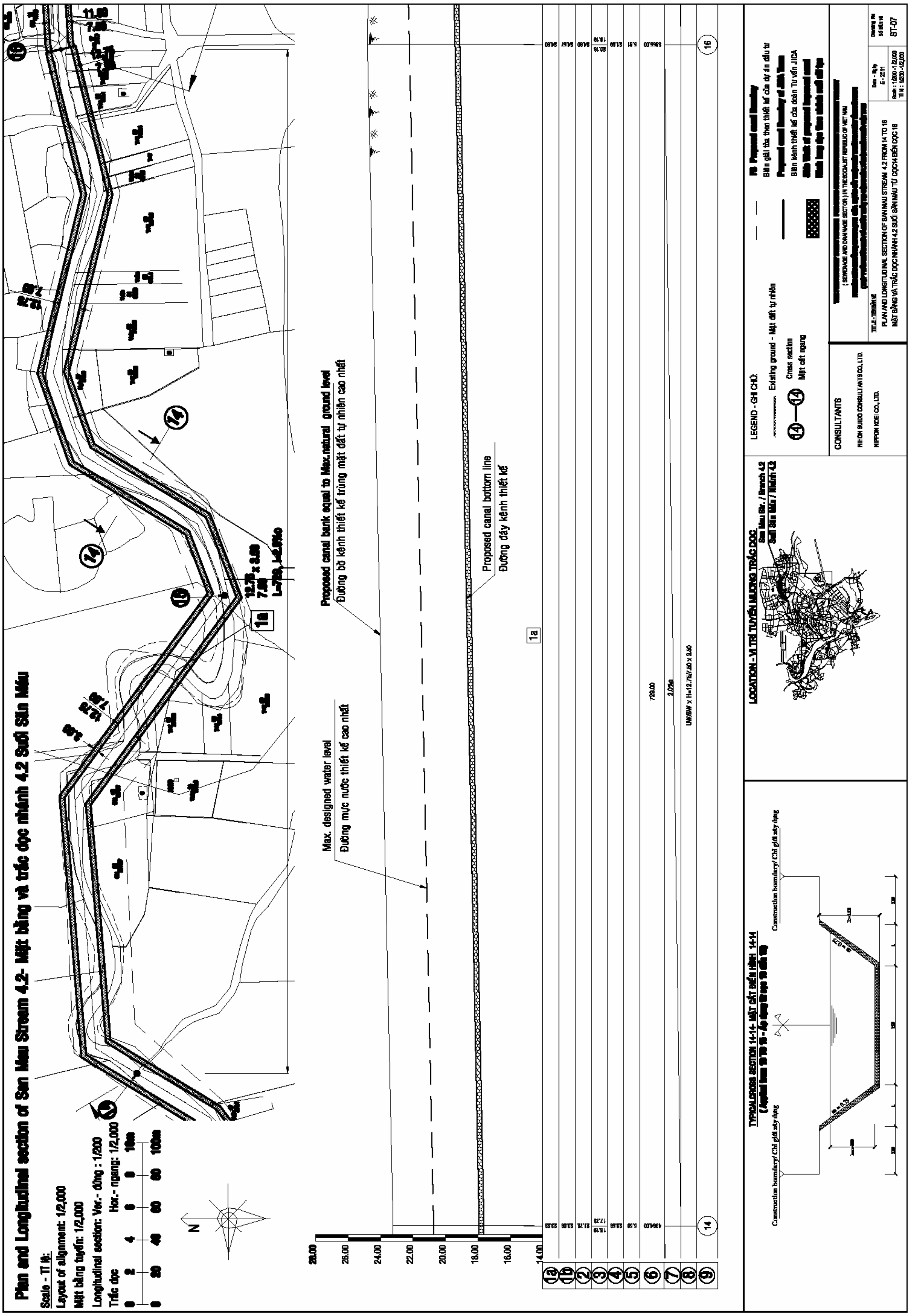

Plan and Longitudinal section of San Mau Stream 4.1- Mặt bằng và trắc dọc nhánh 4.1 Suối Săn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Hor.- ngang: 1/2,000
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
LEGEND - GHI CHÚ:
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
CONSULTANTS
NIHON SUIDO CONSULTANTS CO., LTD
NIPPON KOEI CO., LTD.
Construction boundary/ Chỉ giới xây dựng
ST-02

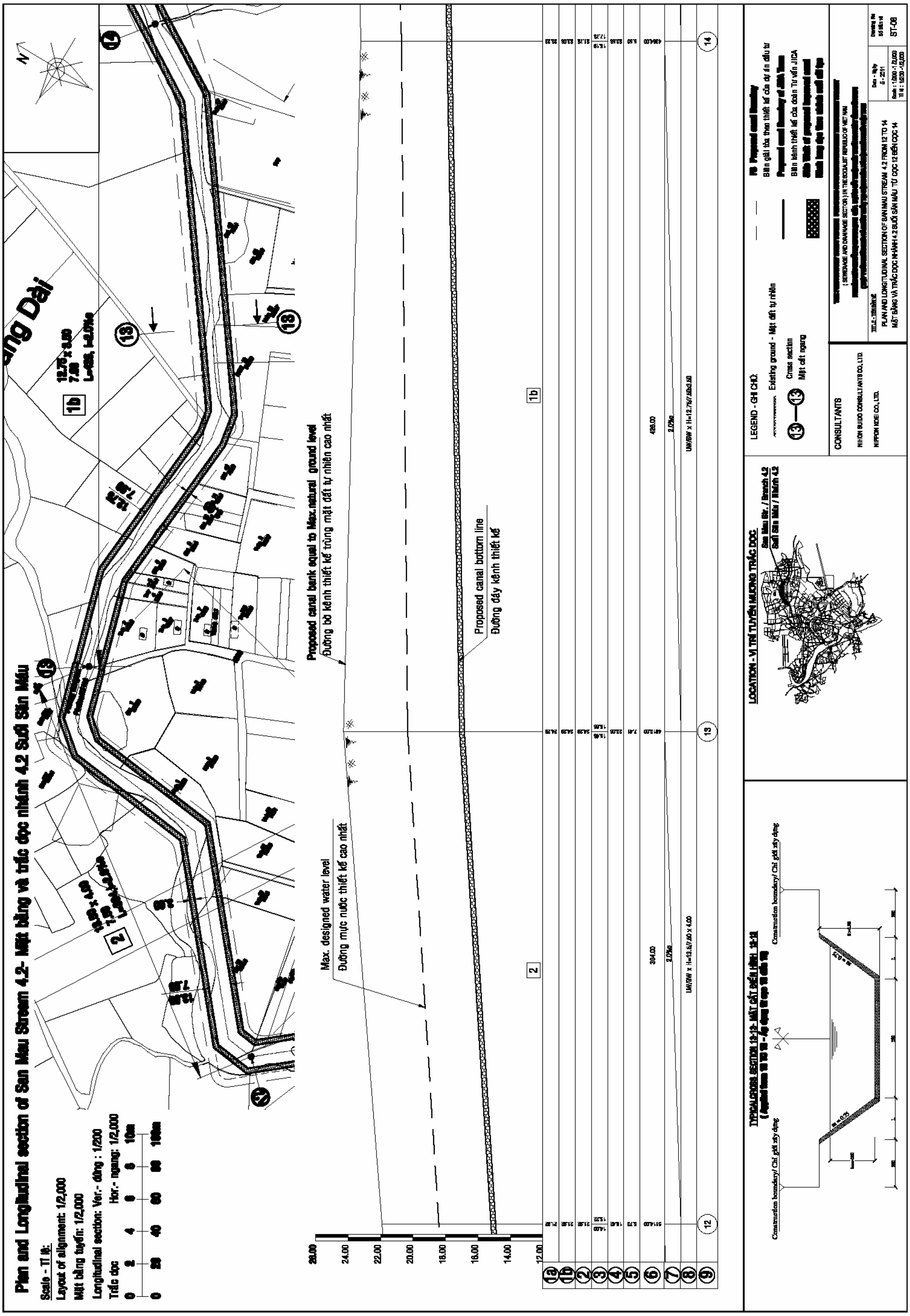

Plan and Longitudinal section of San Mau Stream 4.1 - Mặt bằng và trắc dọc nhánh 4.1 Suối Sặn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Trắc dọc Hor.- ngang: 1/2,000
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
10.70 x 3.20
7.50
L=624, i=2.4‰
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
CONSULTANTS
NIPPON KOEI CO., LTD.
PLAN AND LONGITUDINAL SECTION OF SAN MAU STREAM 4.1 FROM 20 TO 22
MẶT BẰNG VÀ TRẮC DỌC NHÁNH 4.1 SUỐI SẶN MÁU TỪ CỌC 20 ĐẾN CỌC 22
ST-03

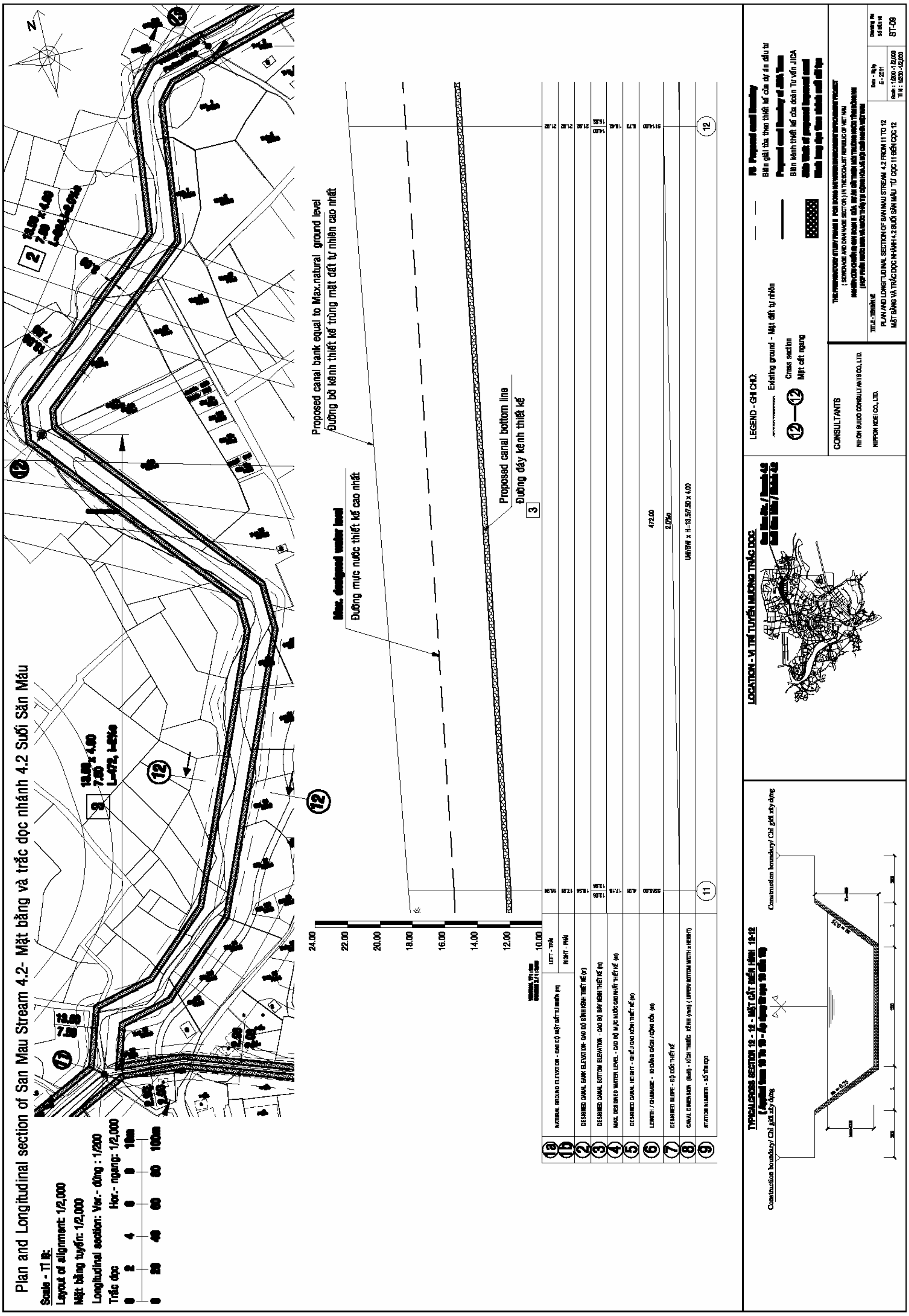

Plan and Longitudinal section of San Mau Stream 4.1
Mặt bằng và trắc dọc nhánh 4.1 Suối Săn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Trắc dọc Hor.- ngang: 1/2,000
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng với mặt đất tự nhiên cao nhất
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
5a
417.00
UW/BW x H=10.70/7.50 x 3.20
19
20
TYPICALCROSS SECTION 17-17- MẶT CẮT ĐIỂN HÌNH 17-17
Construction boundary/ Chỉ giới xây dựng
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
Biên giải tỏa theo thiết kế của dự án đầu tư
Biên kênh thiết kế của đoàn Tư vấn JICA
CONSULTANTS
NIHON SUIDO CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.
PLAN AND LONGITUDINAL SECTION OF SAN MAU STREAM 4.1 FROM 19 TO 20
MẶT BẰNG VÀ TRẮC DỌC NHÁNH 4.1 SUỐI SĂN MÁU TỪ CỌC 19 ĐẾN CỌC 20
ST-04

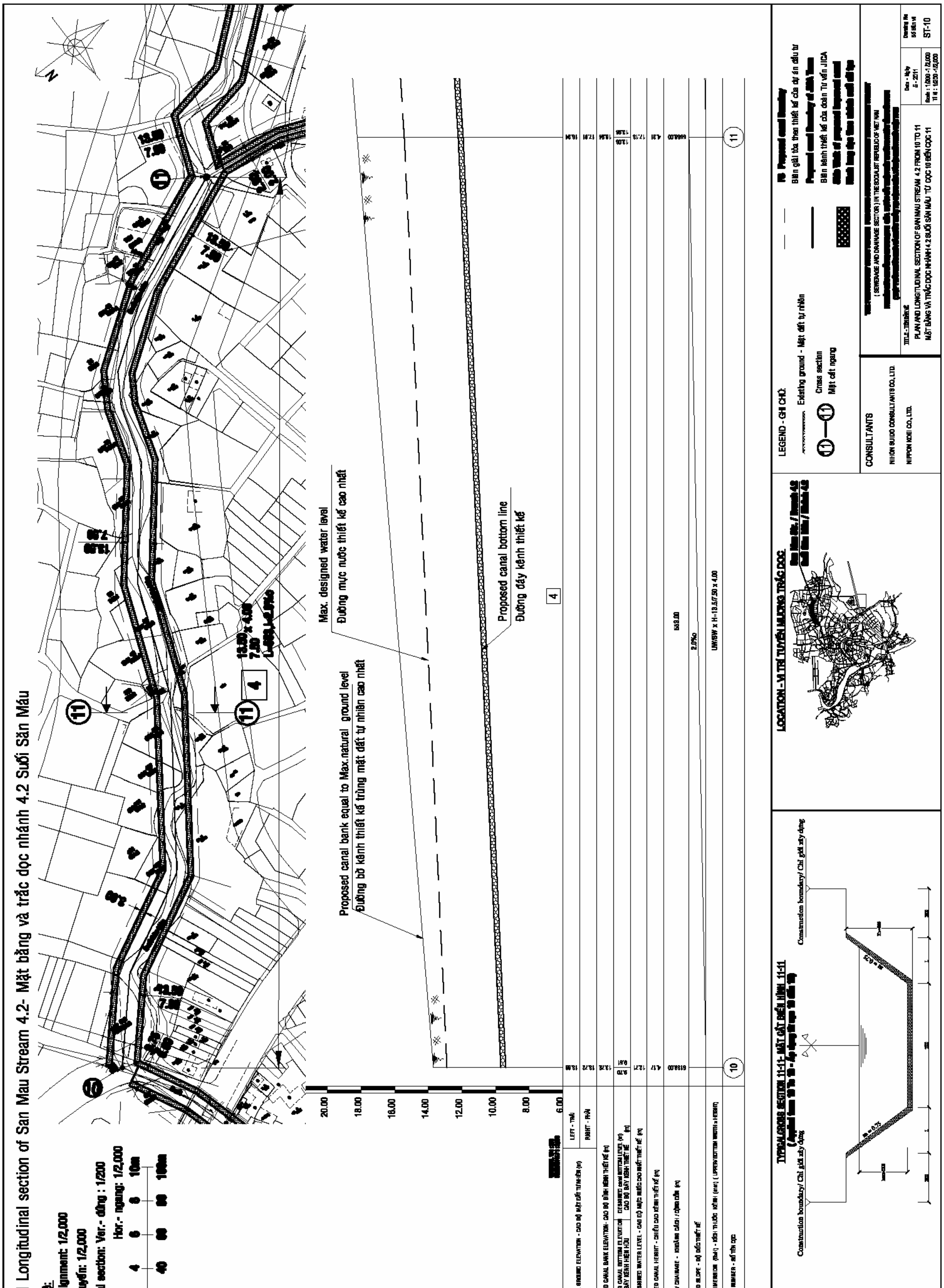

Plan and Longitudinal section of San Mau Stream 4.1- Mặt bằng và trắc dọc nhánh 4.1 Suối Săn Máu
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Proposed canal bank above Max.natural ground level of 17cm
Đường bờ kênh thiết kế cao hơn mặt đất tự nhiên cao nhất 17cm
5b
CONSULTANTS
ST-05

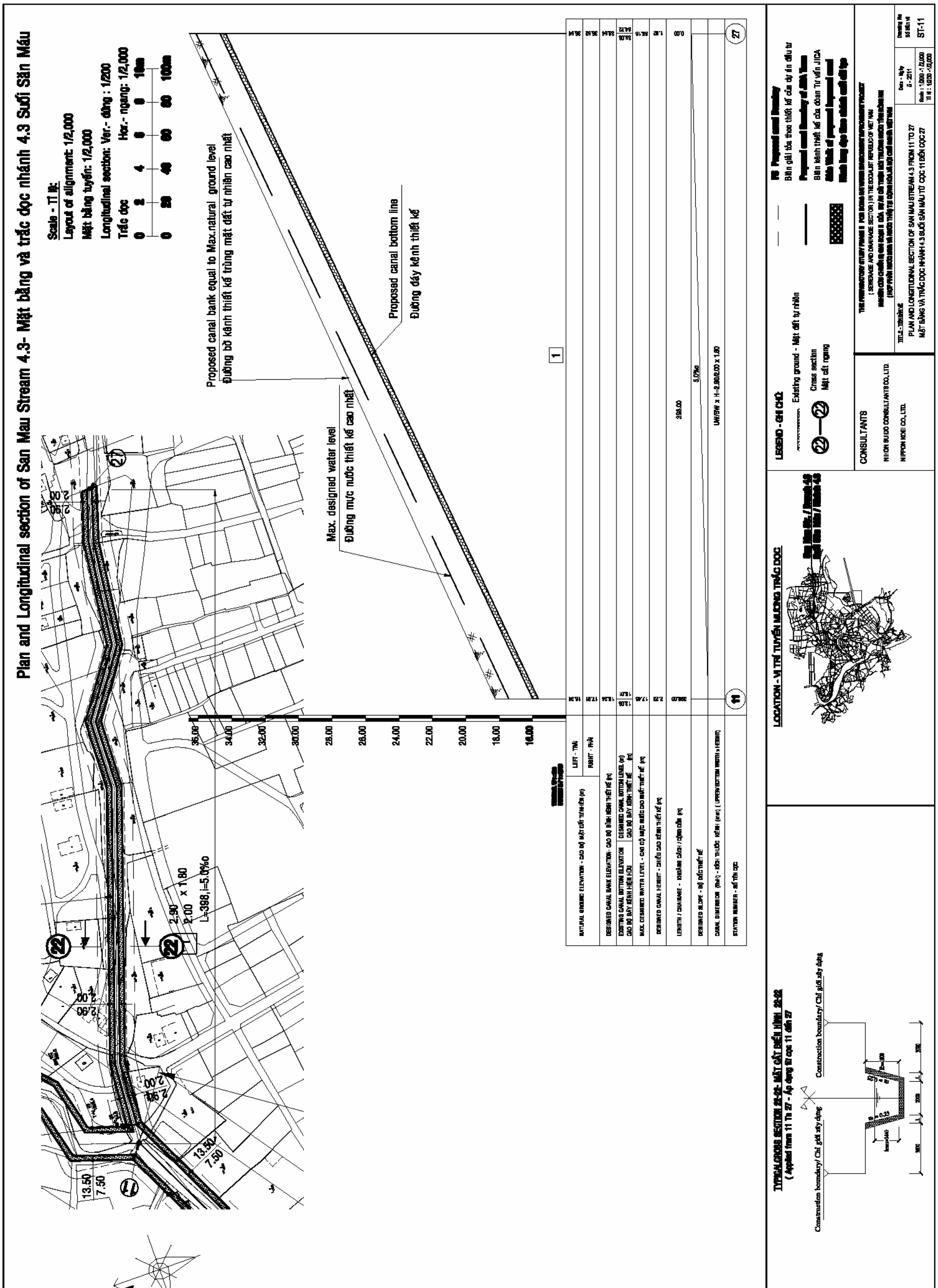

Plan and Longitudinal section of San Mau Stream-4.1
Mặt bằng và trắc dọc nhánh 4.1 Suối Săn Máu
Proposed canal bank above Max.natural ground level of 17cm
Đường bờ kênh thiết kế cao hơn mặt đất tự nhiên cao nhất 17cm
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
CONSULTANTS

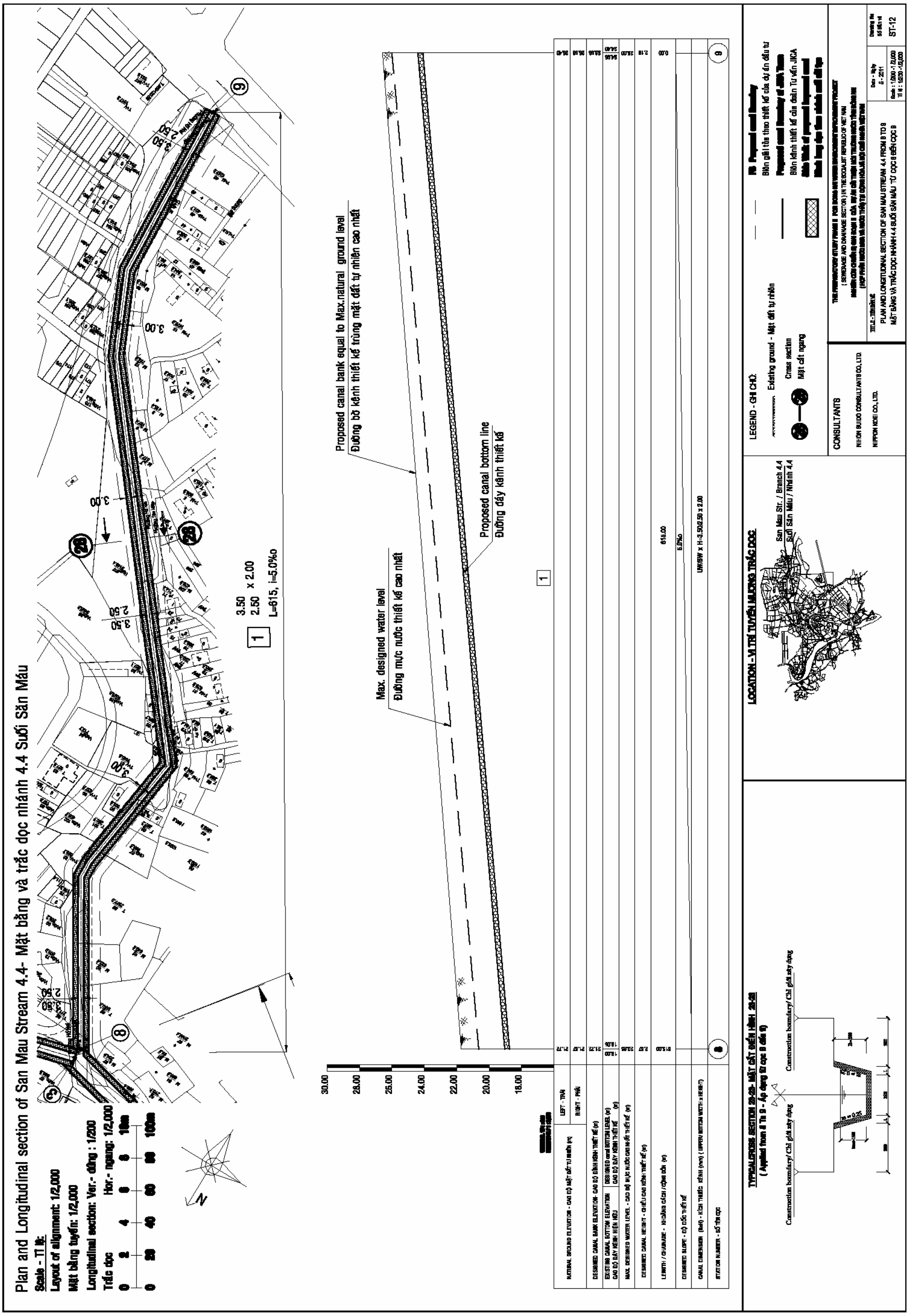

Plan and Longitudinal section of San Mau Stream 4.2- Mặt bằng và trắc dọc nhánh 4.2 Suối Săn Máu
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
LEGEND - GHI CHÚ
CONSULTANTS
ST-07

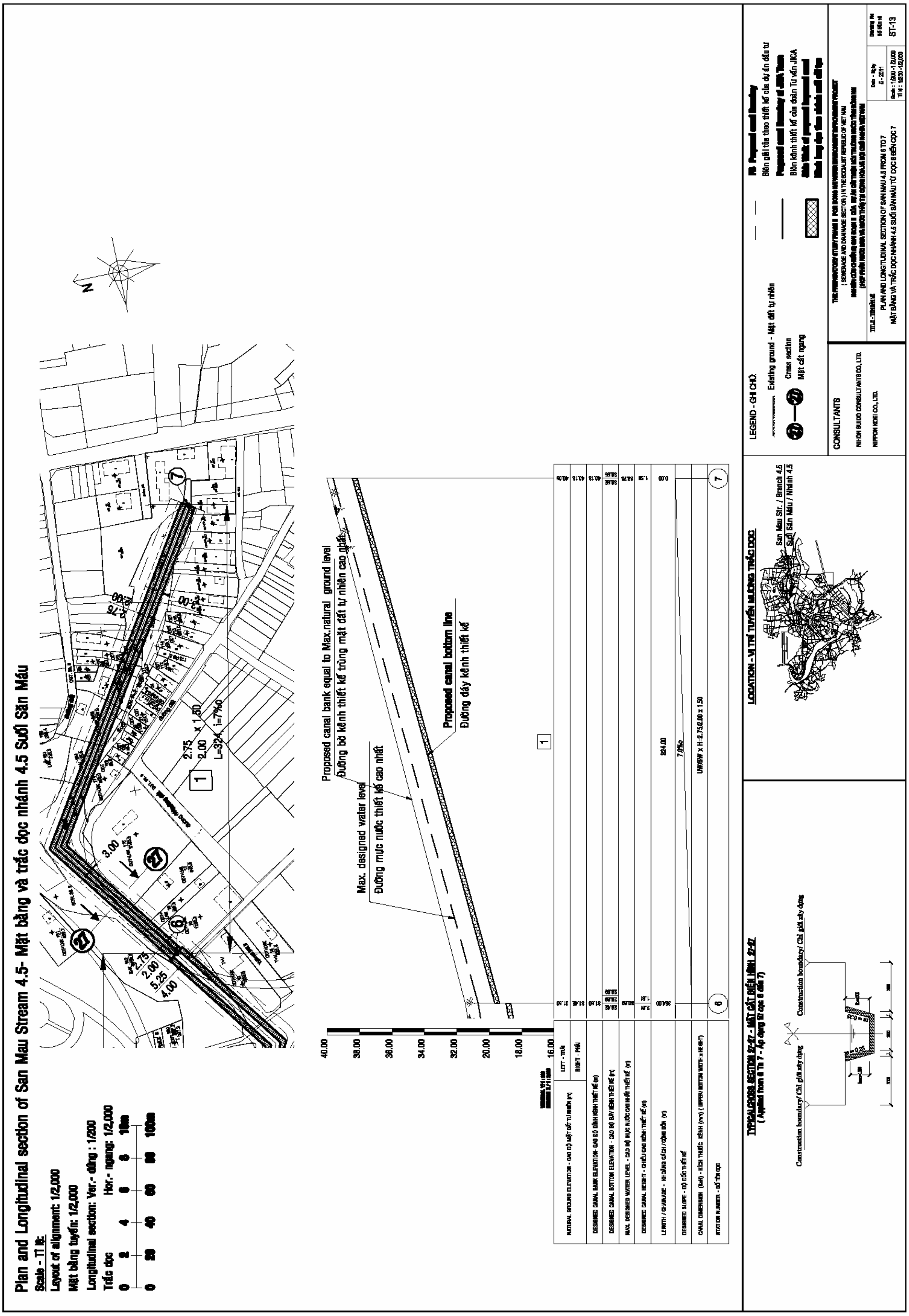

Plan and Longitudinal section of San Mau Stream 4.2- Mặt bằng và trắc dọc nhánh 4.2 Suối Sân Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Hor.- ngang: 1/2,000
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
CONSULTANTS
NIPPON KOEI CO., LTD.
PLAN AND LONGITUDINAL SECTION OF SAN MAU STREAM 4.2 FROM 12 TO 14
MẶT BẰNG VÀ TRẮC DỌC NHÁNH 4.2 SUỐI SÂN MÁU TỪ CỌC 12 ĐẾN CỌC 14
ST-08

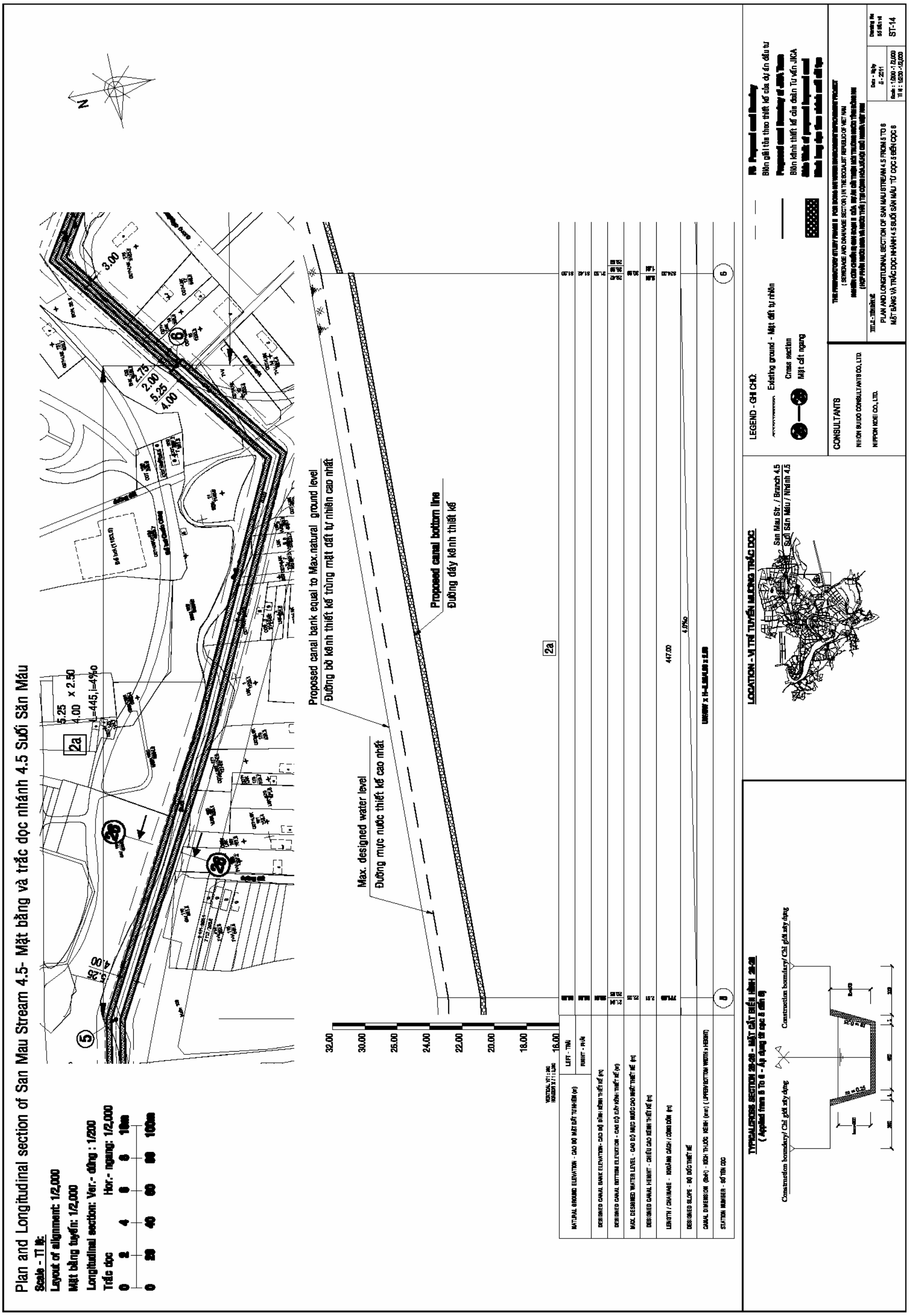

Plan and Longitudinal section of San Mau Stream 4.2- Mặt bằng và trắc dọc nhánh 4.2 Suối Săn Máu
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Đường mực nước thiết kế cao nhất
LEGEND - GHI CHÚ
CONSULTANTS
NIPPON KOEI CO., LTD.
ST-09

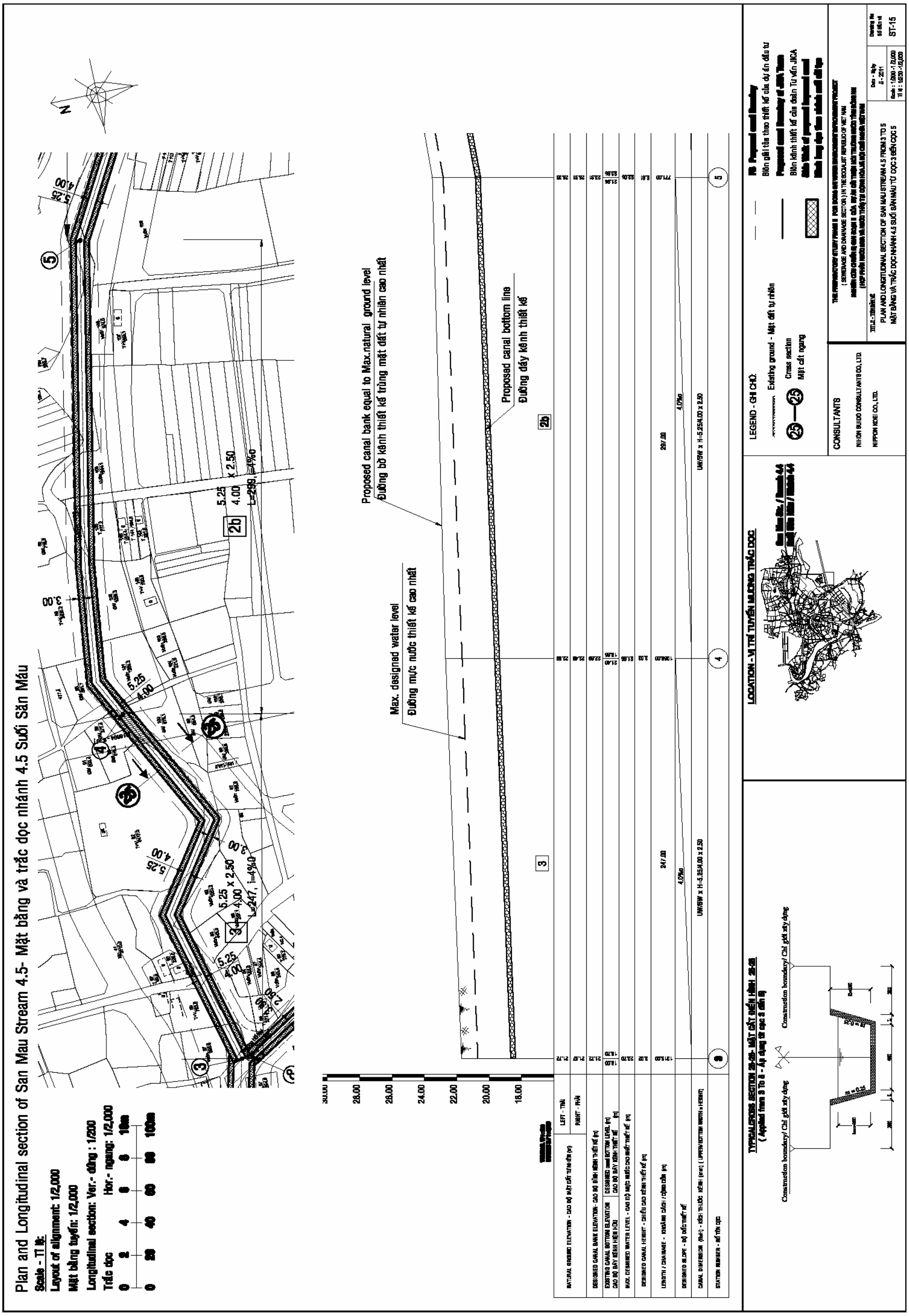

Plan and Longitudinal section of San Mau Stream 4.2- Mặt bằng và trắc dọc nhánh 4.2 Suối Săn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200 Hor.- ngang: 1/2,000
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
Biên giải tỏa theo thiết kế của dự án đầu tư
Biên kênh thiết kế của đoàn Tư vấn JICA
CONSULTANTS
NIHON SUIDO CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.
PLAN AND LONGITUDINAL SECTION OF SAN MAU STREAM 4.2 FROM 10 TO 11
MẶT BẰNG VÀ TRẮC DỌC NHÁNH 4.2 SUỐI SĂN MÁU TỪ CỌC 10 ĐẾN CỌC 11
ST-10
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
Construction boundary/ Chỉ giới xây dựng

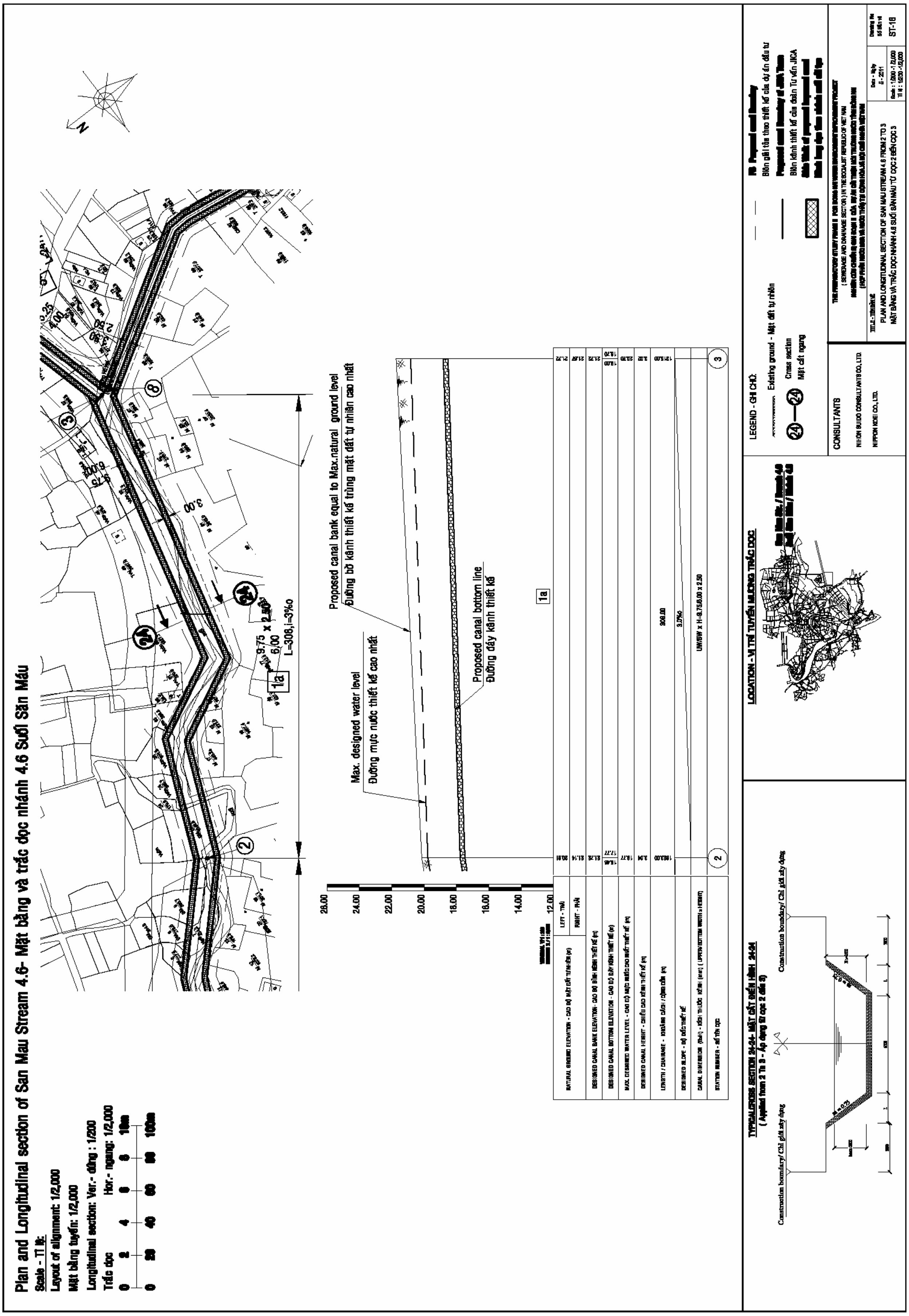

Plan and Longitudinal section of San Mau Stream 4.3- Mặt bằng và trắc dọc nhánh 4.3 Suối Săn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Trắc dọc Hor.- ngang: 1/2,000
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
2.90 x 1.80
2.00
L=398, i=5.0‰
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
CONSULTANTS
NIPPON KOEI CO., LTD.
ST-11

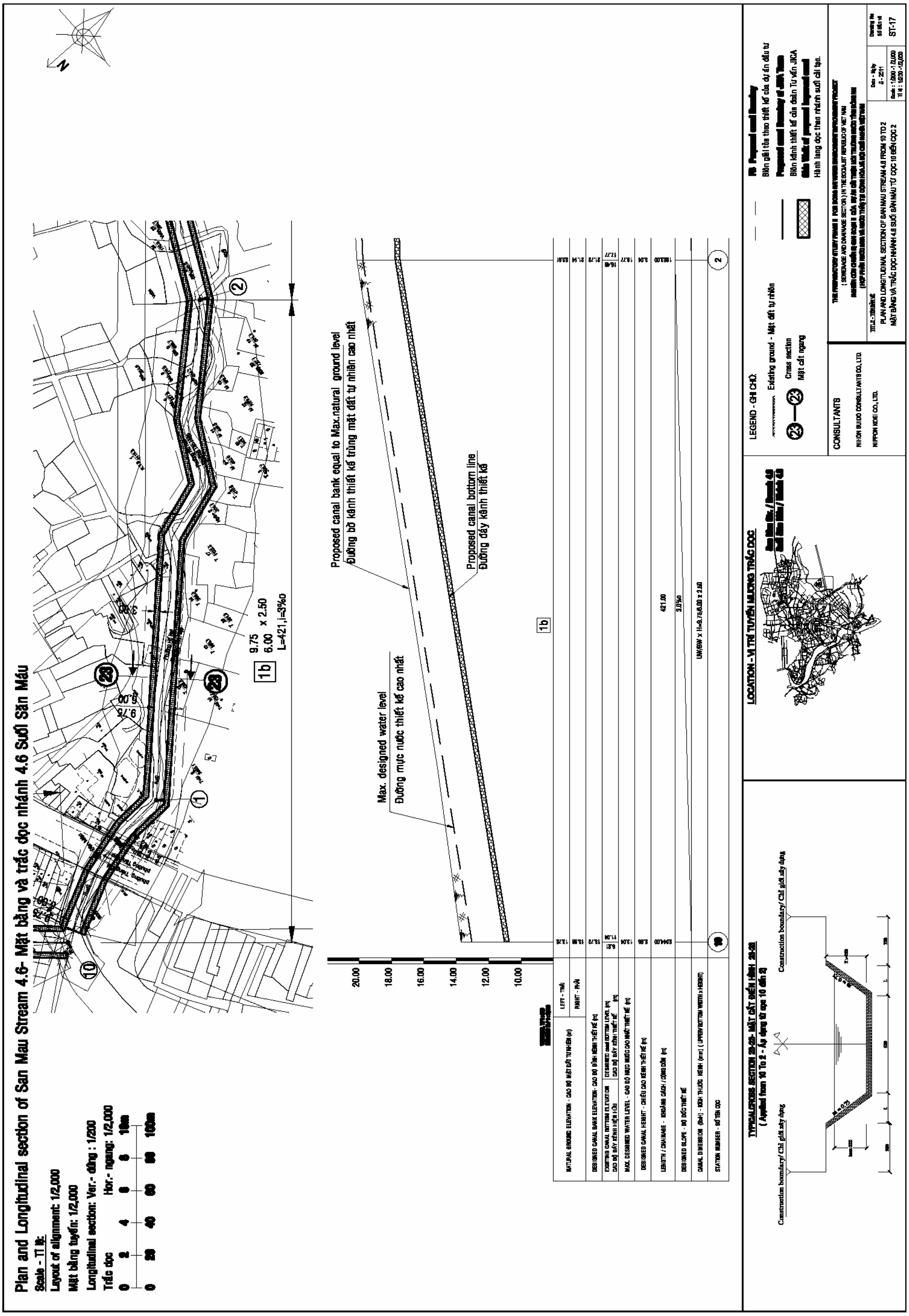

Plan and Longitudinal section of San Mau Stream 4.4- Mặt bằng và trắc dọc nhánh 4.4 Suối Săn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200 Hor.- ngang: 1/2,000
Trắc dọc
3.50 x 2.00
2.50
L=615, i=5.0‰
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
LEGEND - GHI CHÚ
CONSULTANTS
ST-12

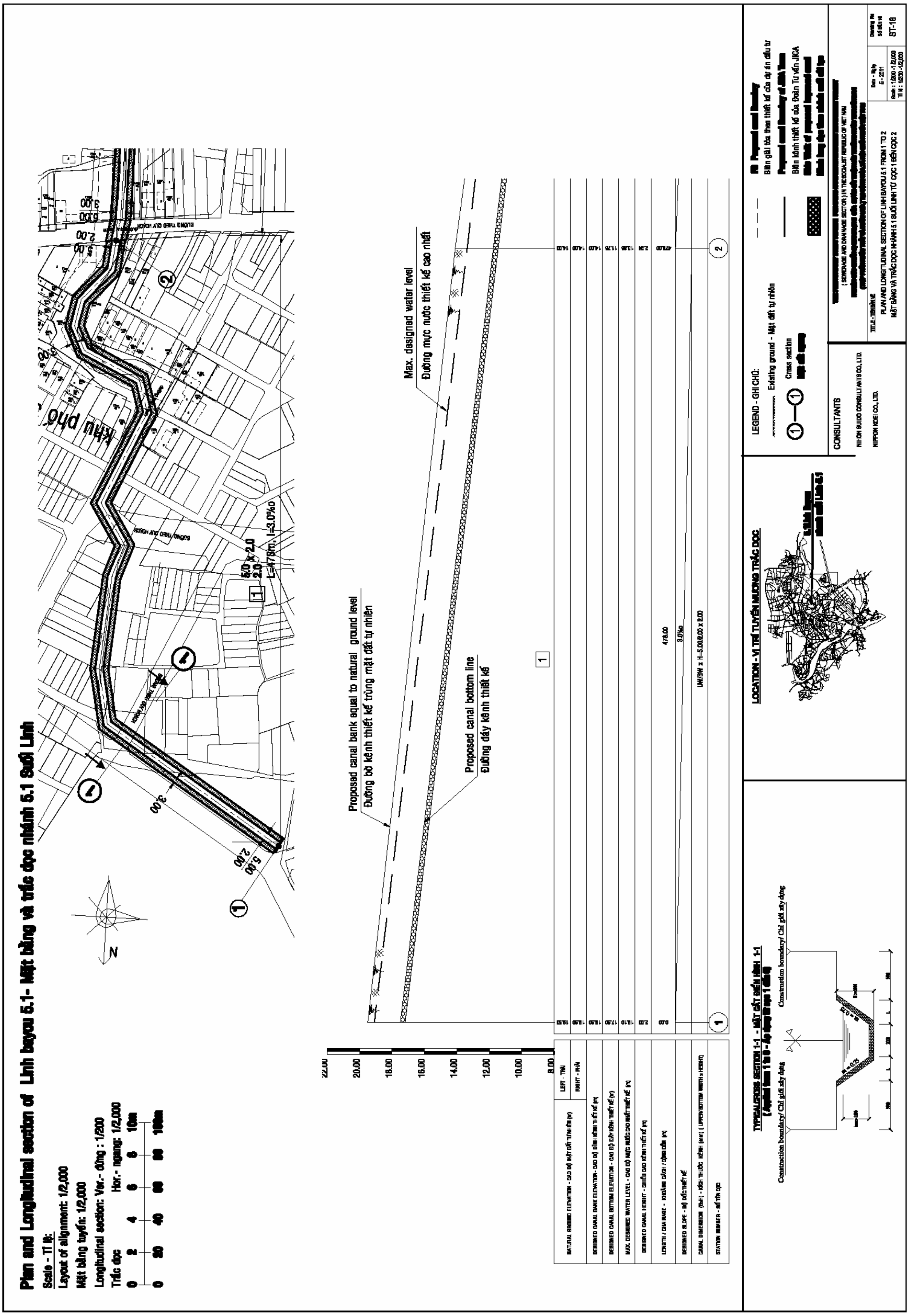

Plan and Longitudinal section of San Mau Stream 4.5- Mặt bằng và trắc dọc nhánh 4.5 Suối Săn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Trắc dọc Hor.- ngang: 1/2,000
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
2.75
2.00 x 1.50
L=324 I=7‰
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
San Mau Str. / Branch 4.5
Suối Săn Máu / Nhánh 4.5
CONSULTANTS
NIHON SUIDO CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.
ST-13

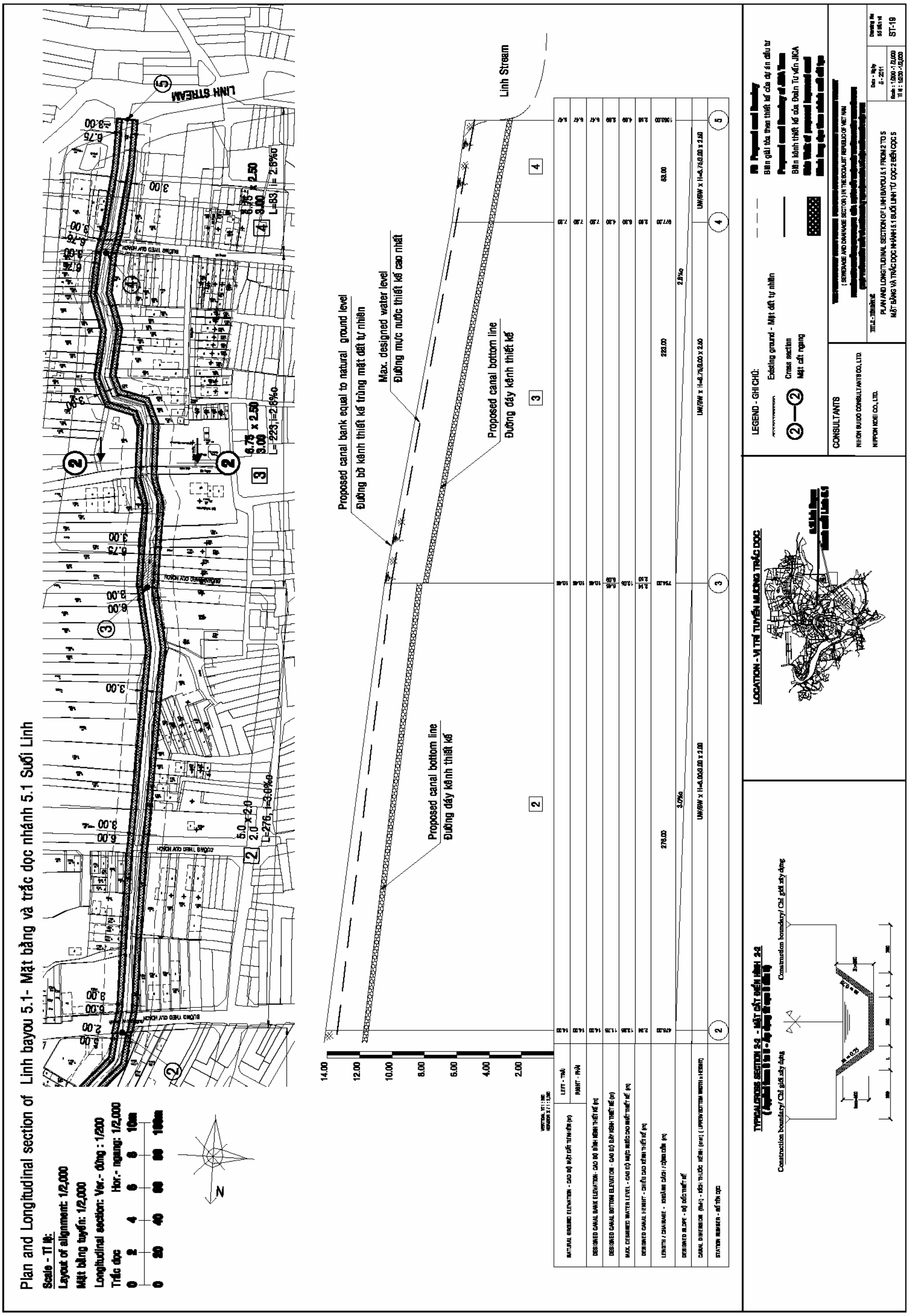

Plan and Longitudinal section of San Mau Stream 4.5- Mặt bằng và trắc dọc nhánh 4.5 Suối Săn Máu
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200 Hor.- ngang: 1/2,000
Trắc dọc
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
San Mau Str. / Branch 4.5
Suối Săn Máu / Nhánh 4.5
CONSULTANTS
NIPPON KOEI CO., LTD.
PLAN AND LONGITUDINAL SECTION OF SAN MAU STREAM 4.5 FROM 5 TO 6
MẶT BẰNG VÀ TRẮC DỌC NHÁNH 4.5 SUỐI SĂN MÁU TỪ CỌC 5 ĐẾN CỌC 6
ST-14

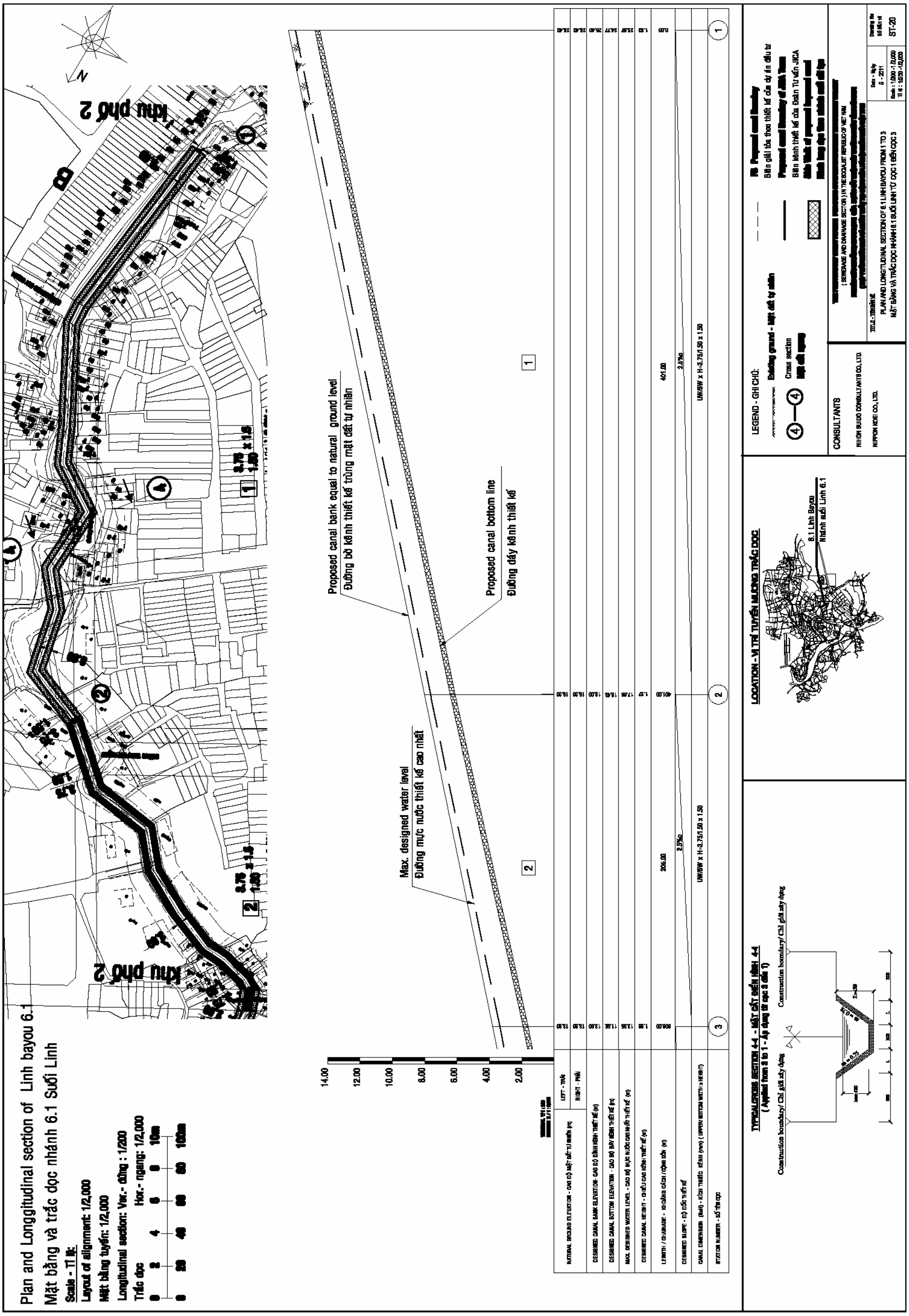

Plan and Longitudinal section of San Mau Stream 4.5- Mặt bằng và trắc dọc nhánh 4.5 Suối Săn Máu
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
LEGEND - GHI CHÚ
CONSULTANTS
ST-15

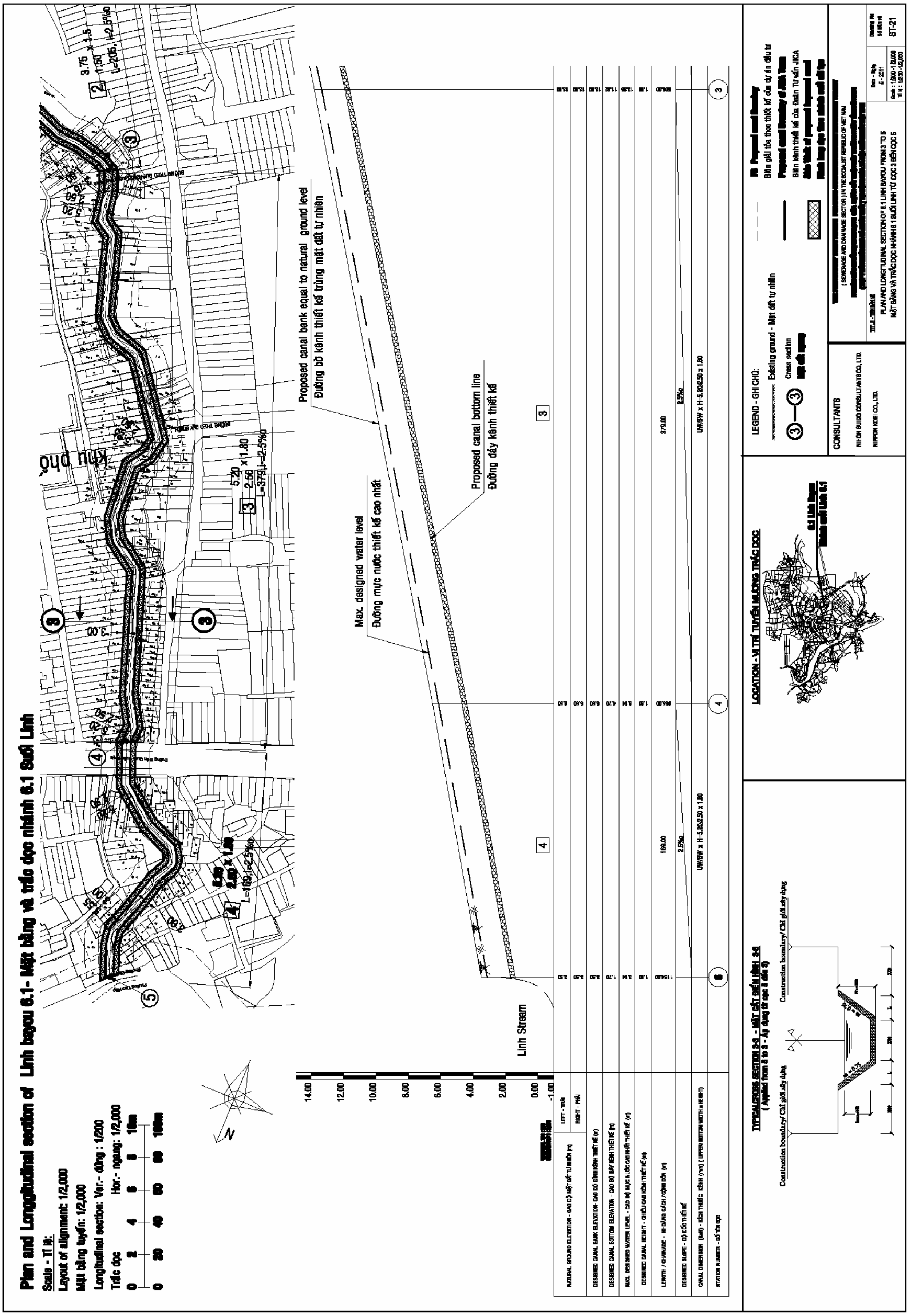

Plan and Longitudinal section of San Mau Stream 4.6- Mặt bằng và trắc dọc nhánh 4.6 Suối Săn Máu
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
L=308,i=3‰
LEGEND - GHI CHÚ
CONSULTANTS
ST-16

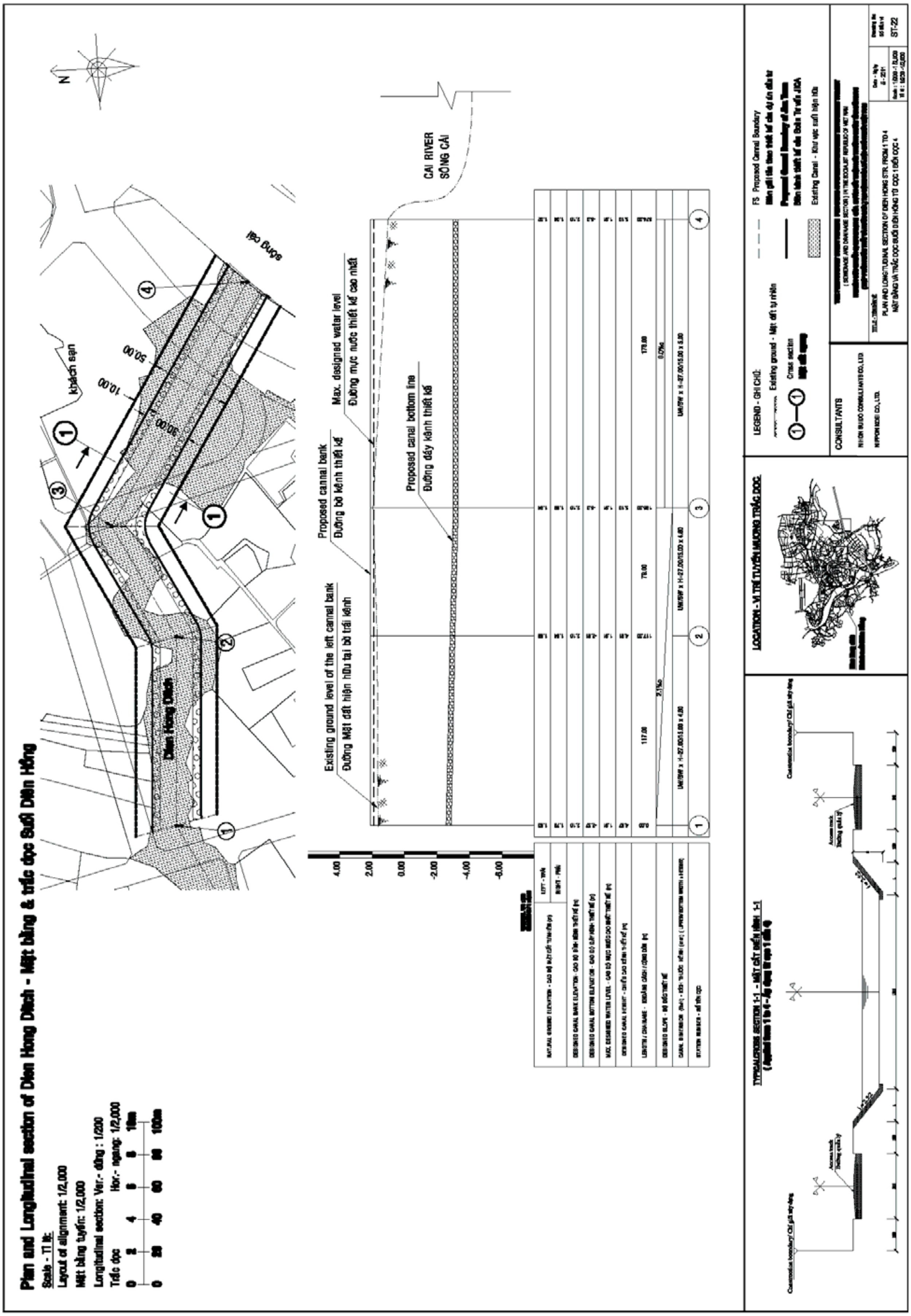

Plan and Longitudinal section of San Mau Stream 4.6- Mặt bằng và trắc dọc nhánh 4.6 Suối Săn Máu
Proposed canal bank equal to Max.natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
9.75 x 2.50
6.00
L=421,i=3‰
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
CONSULTANTS
ST-17


Plan and Longitudinal section of Linh bayou 5.1- Mặt bằng và trắc dọc nhánh 5.1 Suối Linh
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Hor.- ngang: 1/2,000
Trắc dọc
Proposed canal bank equal to natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
L=478m, I=3.0‰
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
LEGEND - GHI CHÚ:
Existing ground - Mặt đất tự nhiên
Cross section
CONSULTANTS
NIPPON KOEI CO., LTD.
ST-18


Plan and Longitudinal section of Linh bayou 5.1- Mặt bằng và trắc dọc nhánh 5.1 Suối Linh
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Trắc dọc Hor.- ngang: 1/2,000
LINH STREAM
Linh Stream
Proposed canal bank equal to natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bottom line
Đường đáy kênh thiết kế
LEGEND - GHI CHÚ:
Existing ground - Mặt đất tự nhiên
Cross section
Mặt cắt ngang
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
CONSULTANTS
ST-19

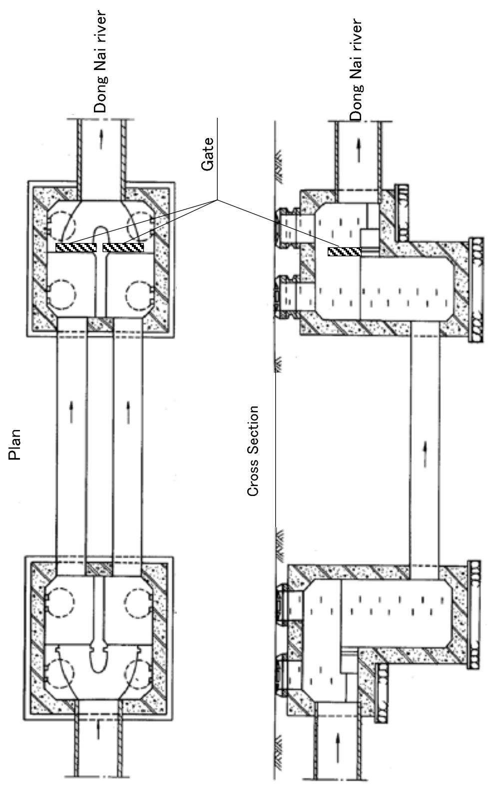

Plan and Longgitudinal section of Linh bayou 6.1
Mặt bằng và trắc dọc nhánh 6.1 Suối Linh
Scale - Tỉ lệ:
Layout of alignment: 1/2,000
Mặt bằng tuyến: 1/2,000
Longitudinal section: Ver.- đứng : 1/200
Trắc dọc Hor.- ngang: 1/2,000
khu phố 2
Proposed canal bank equal to natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
6.1 Linh Bayou
Nhánh suối Linh 6.1
LEGEND - GHI CHÚ
Existing ground - Mặt đất tự nhiên
Cross section
CONSULTANTS
NIPPON KOEI CO., LTD.
ST-20


Plan and Longitudinal section of Linh bayou 6.1- Mặt bằng và trắc dọc nhánh 6.1 Suối Linh
Proposed canal bank equal to natural ground level
Đường bờ kênh thiết kế trùng mặt đất tự nhiên
Proposed canal bottom line
Đường đáy kênh thiết kế
Max. designed water level
Đường mực nước thiết kế cao nhất
Linh Stream
LEGEND - GHI CHÚ:
CONSULTANTS
LOCATION - VỊ TRÍ TUYẾN MƯƠNG TRẮC DỌC
ST-21

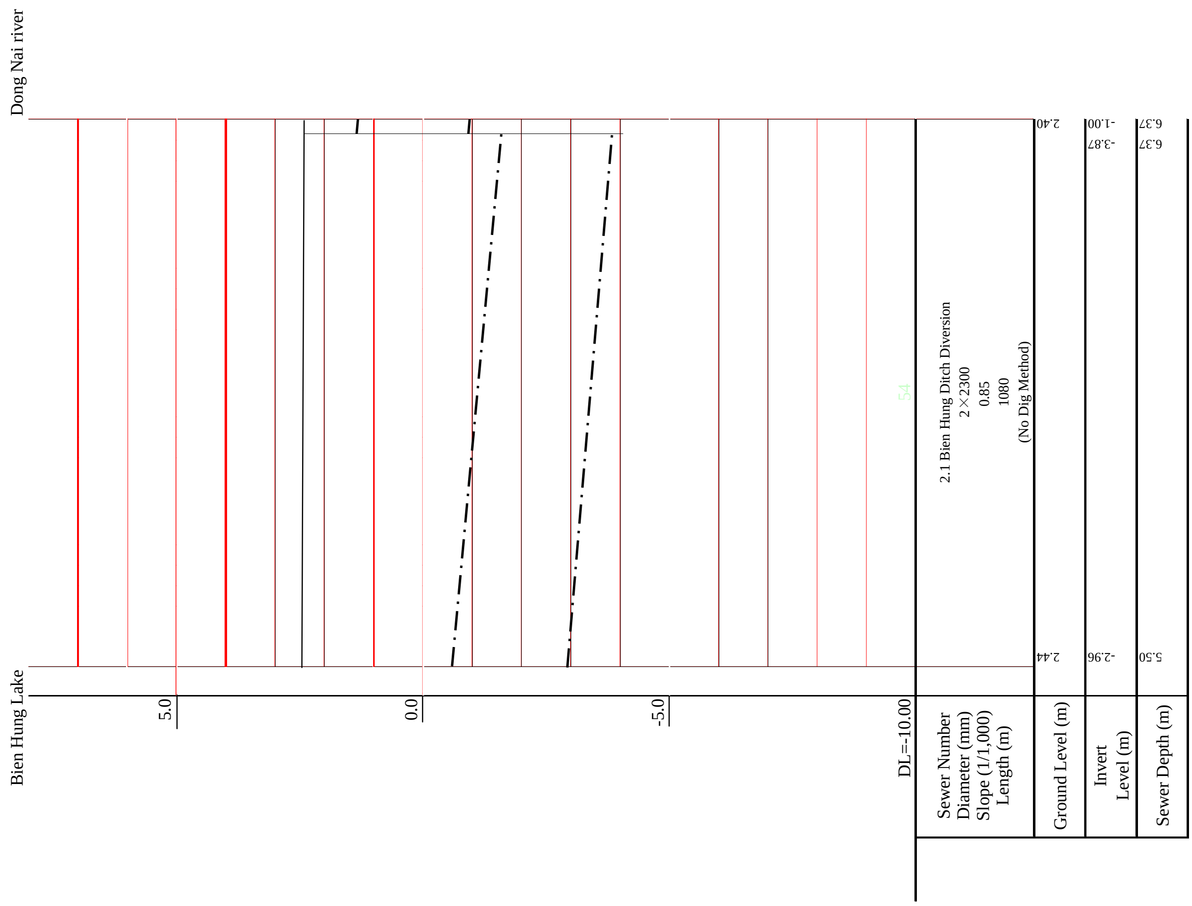

Plan and Longitudinal section of Dien Hong Ditch - Mặt bằng & trắc dọc Suối Điền Hồng
CAI RIVER
SÔNG CÁI
Max. designed water level
Đường mực nước thiết kế cao nhất
Proposed canal bank
Đường bờ kênh thiết kế
Proposed canal bottom line
Đường đáy kênh thiết kế
Existing ground level of the left canal bank
Đường Mặt đất hiện hữu tại bờ trái kênh
LEGEND - GHI CHÚ:
CONSULTANTS
ST-22

Appendix 6-F

Sample Drawing of "2.1 Bien Hung Ditch Diversion"



Typical Drauwing of Siphon



Appendix 7-A

Questionnaire for Household Survey

QUESTIONNAIRE FOR HOUSEHOLD SURVEY
SEWERAGE CONNECTION PROJECT
IN BIEN HOA CITY

QUESTIONNAIRE No : (1) CLOSE – ENDED VERSION

(INTERVIEWER TO FILL

INTERVIEWER	
Date of the interview::	

Name of respondent :	
Ward	
Address:	

)

(***Read***) My name is ______________________, and I am working with a team of researchers investigating the households' perception and attitude toward the environment in general and sanitation improvement in Bien Hoa City . As you may know, all the wastewater from households in Bien Hoa City is being discharged to nearby canals and rivers without any treatment. If this situation continues, it is expected that this may lead to serious water pollution in the City, with potential impacts on the health of the citizens, contaminated surface water and groundwater, bad smell, and reduced quality of life in the City. We are interested in understanding your opinions on the environment, and on water pollution in Bien Hoa City.

We are interviewing 400 households in Bien Hoa City. Your household was selected just by chance. I am going to ask you a number of questions. Please answer these questions the best you can. There is no right or wrong answer to the question. We only want to know your true opinions on those issues.

If you are not sure about the answer to a question, please feel free to discuss with your family before answering the question. If you do not understand a question, please tell me and I will repeat and explain the question. If you wish to stop the interview or do not wish to answer a specific question, please tell me**.**

Please note that your answers to the questions will be used solely for purposes of research and analysis. Your answers will be treated confidentially and never be used for other purposes.

The interview will take about 1 hour. At the end of the interview, I will provide you with a small gift to thank you for your collaboration.

Are you willing to be interviewed at this moment?

SURVEYOR:

If YES: Proceed with interview

If NO: Ask for an alternative day and time to come back.
DAY: TIME:

If the person does not wish to commit to a specific day and time, go next door. Repeat this process until a person is willing to respond.

I. Environmental Attitudes and Perceptions

Firstly, I'm going to ask you a few questions about your perception on the environment in general and Bien Hoa City in particular. Again, simply answer these questions the best you can. There is no right or wrong answer. We simply want to know your true opinions.

1.1 I am going to list for you 5 objectives which the authorities of Bien Hoa City may try to achieve. After I finish the list .
(SURVEYOR: If No, repeat the above. If Yes, read the list below):

(1) Promote economic growth
(2) Improve health care services
(3) Improve schools and education
(4) Reduce water pollution
(5) Reduce air pollution

According to you:

① Which of these objectives is the first most important to achieve? # ______ 99. Don't know
② Second most important? # ______99. Don't know
③ Third most important? # ______ 99. Don't know

1.2 In the above list of objectives, is there any other objective which was not listed which you think should be a priority?

① If Yes, please describe: ____

Would this be first, second, or third most important objective to achieve by Bien Hoa City authorities?
First: ____; Second: ____; Third: ____

② No.

1.3 Have you ever heard about any environmental issues of Bien Hoa City on TV, the radio, newspapers, magazines, or by community groups in the <u>past 12 months</u>?
① Yes, a few times. Go to question 1.4
② Yes, many times. Go to question 1.4
③ No, never. Go to question 1.5
99. I am not sure. Go to question 1.5

1.4 What were the issues you recall being most often presented?
____

1.5 Do you think that environmental quality in Bien Hoa City is properly managed?

① Yes ② No 99. I am not sure

1.6 I am going to list for you 5 environmental issues which may be a problem in Bien Hoa City.

(1) Lack of treatment of wastewater
(2) Not so good solid waste disposal and garbage collection
(3) Air pollution
(4) Noise pollution
(5) Pollution of the water canals and rivers in the City

According to you:

① Which of the above environmental issues may be the first most important problem in Bien Hoa City? # ______ 99. Don't know
② Second most important? # ______99. Don't know
③ Third most important? # ______ 99. Don't know

1.7 In the above list of environmental issues, is there any other issue which was not listed which you think should be a priority?______________________________________

① If Yes: Please describe: ____

Would this be first, second, or third most important issue to be addressed by Bien hoa city authorities? First: ____; Second: ____; Third: ____

② No.

(***Read***) Now, I am going to read to you a number of statements. After each statement, I am going to ask you if you "strongly disagree" with the statement, or if you "disagree" with the statement, or if "agree" or "strongly disagree" with the statement. Again, there is no right or wrong answer. Please just answer your true opinion.

1.8 Bien Hoa City needs to accelerate the industrialization and urbanization to increase jobs and incomes even if this implies increasing pollution and reducing environmental quality in Bien Hoa City.

1	2	3	4	5	99
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't Know

1.9 We, as citizens of Bien Hoa City should sacrifice some of our income and standard of living so that the next generation may benefit from a better environment.

1	2	3	4	5	99
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't Know

1.10 The Environmental Protection Law of Viet Nam states that 'Environmental Protection is the cause of the whole society, the right as well responsibility of state agencies, organizations, households and individuals'. Do you strongly disagree, disagree, agree, or strongly agree with this statement?

1	2	3	4	5	99
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't Know

1.11 I am going to list for you 4 stakeholders which rights and responsibilities for environmental protection in Bien Hoa City.

(1) Government
(2) Enterprises located in Bien Hoa City
(3) Social organizations (such as Women Union, Fatherfront, Youth Union, Veterans, etc.)
(4) Households and Individual citizens

According to you:

① Which of the stakeholders listed above has the first most important responsibility for environmental protection in Bien Hoa City? # ______ 99. Don't know
② Second? # ______99. Don't know
③ Third? # ______ 99. Don't know

1.12 In the above list of stakeholders, is there any other stakeholder which was not listed which you think should be listed?

① Yes. If Yes: Please describe: ____

Would this be first, second, or third most important stakeholder with environmental responsibilities?

First: ____; Second: ____; Third: ____

② No.

1.13 I am going to list for you 6 different types of contribution which household in Bien Hoa City can make to protect and improve the environment in the City. Afer I finish the list .
(SURVEYOR: If No, repeat. If Yes, read the list):

(1) Participate in Environment Day
(2) Participate in the 3P Program
(3) Keep our house clean
(4) Try to reduce water consumption
(5) Discard solid waste collection properly
(6) Contributing money to environmental activities

① Which of the possible contributions listed above has the first most important responsibility for environmental protection in Bien Hoa City? # ______ 99. Don't know
② Second? # ______99. Don't know
③ Third? # ______ 99. Don't know

1.14 Is there any other type of contribution which was not listed which you think should be listed? :

① Yes. If Yes: Please describe: ____

Would this be first, second, or third most important contribution by households?
First: ____; Second: ____; Third: ____

② No.

1.15 Do you know that all household wastewater in Bien Hoa City go into environment (canals and rivers …) without any treatment?

① Yes, I know ② No , I don't know99. I am not sure

1.16 Do you believe that in the past the wastewater from the households has polluted environment (the rivers and canals …) in Bien Hoa City?

① Yes, I believe so ② No , I don't believe so 99. I am not sure

1.17 Do you believe that in the future if the wastewater from the households is not treated it could pollute the rivers and canals in Bien Hoa City?

① Yes, very significantly ② Yes, slightly ③ No, I don't believe so 99. I am not sure

1.18 In your opinion, has the sanitation condition of Bien Hoa City been getting better, getting worse, or staying the same, over the past five years?

① Getting worse ② Staying the same ③ Getting better 99. I don't know

1.19 Do you feel that improving the cleanliness (hygiene) condition of Bien Hoa City is very important to you?

① Yes, very important.
② Yes, important
③ No, not very important
④ No, not important at all

1.20 Please tell me why.
____
____
____

1.21 Do you agree that the enterprise should pay for their wastewater to be treated?

① Yes ② No 99. I am not sure

1.22. Do you agree that households should pay for their wastewater to be treated?

① Yes ② No 99. I am not sure

II. WATER SUPPLY AND SANITARY SITUATION .

2.1 Which source of water does your household use for daily life:

① Water Supply Company only
② Water Supply Company and private well
③ Private well only
④ Tank of rain water
Other (specify______________________________)

SURVEYOR: If ① or ② is answered, go to Question 2.2; 2.3

SURVEYOR: Ask if it would be possible to see last month water bill to validate information.

2.2 On average per month, how much is your water bill? ________________

2.3 On average per month, how much cubic meter in your water bill: _____________

2.4 Why does your household use a private well?

① No connection to Water Supply Company
② Private well is less costly
99. Other. Specify: ______________________________________

2.5. Does your house have a septic tank?

1. Yes
2. No *(go to III)*

2.6. Has your septic tank ever been emptied?

1. Yes Last time (date):
2. Never.

2.7. Do you have any problems with your septic tank and its related pipelines?

1. Normally 2. Blockage
3. Flooded in the rain season 4. Overflow and polluted

2.8. To where is your outlet connection discharged?

1. To the public sewerage system
2. Free soak-away to surrounding
3. Gadern , road , lane ,Nearby pond , lake , chanel …
4. Don’t Know

2.9 Are you willing to abandon your septic tank and reconnect your related pipelines, and discharge directly to the outside sewer after its construction?

1. Yes
2. No Why?

III. SEWERAGE CONNECTION PLAN

The authorities of Bien hoa recently expressed the interest to adopt a number of actions to protect environment .

One of the projects to mitigate the environmental pollution and to protect the public health is to have a sewage system to collect all the wastewater discharged from households in Bien Hoa City, and to bring this wastewater to a wastewater treatment plant for treatment. In doing that, the project will reduce water pollution discharged in the rivers and canals of the City, and greatly improve environmental quality for all the citizens of the City.

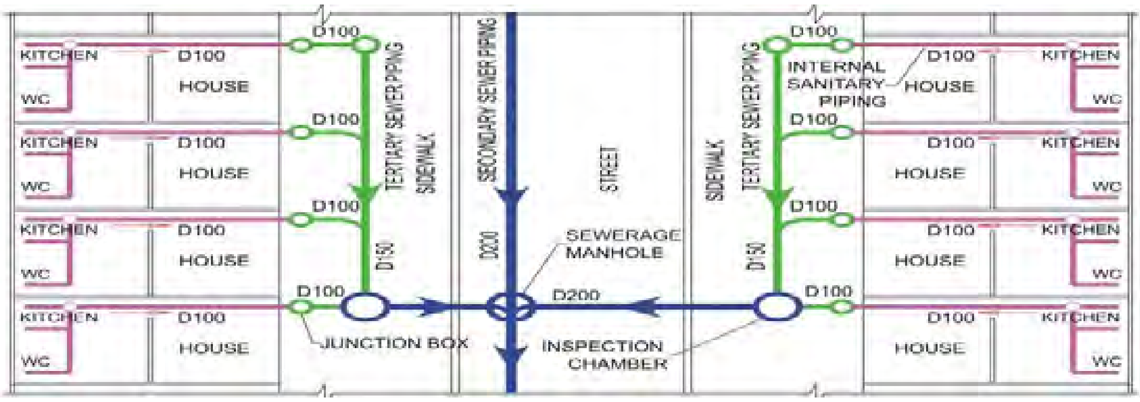
This project is funded from the budget of the Government of Viet Nam, and also from a loan provided to the Government of Viet Nam by the Government of Japan. The Government of Viet Nam will have to pay back this loan to the Government of Japan. The project also receives contribution from the authorities of Dong Nai Province and Bien Hoa City.

3.1. Have you heard about this project in the news or elsewhere?

① Yes ② No 99. I am not sure

(Read) Now I'd like to take a few minutes and explain this sanitation project to you.

A sewer system is a network of pipes underground that is used to carry wastewater. The sewer pipes are usually placed underground along streets and lanes. The attached figure illustrates how a system of sewer pipes would work.



Secondary sewer piping (in the street pipeline)

Tertiary sewer piping (in sidewalk to the households)

When a house is connected to the sewer pipe, all the wastewater from the house (bathing, laundry, cooking, etc) flows into the pipe and is then sent to the wastewater treatment plant for treatment. .

Wastewater from large industries does not go into the sewer system. Most large industries have to treat their waste water separately.

In the above diagram, the secondary sewer piping and tertiary sewer piping will be funded by the project I have described to you. However, it is the responsibility of the households to connect their house to the sewer piping system.

SURVEYOR ASK: Is this description clear to you? If NOT clear, repeat the above and/or ask what is not clear. IF YES CLEAR, continue below.

If a sewer system were built in Bien Hoa City and the households connect their house to the sewer system, the citizens of Bien Hoa City would obtain at least three kinds of benefits:

- The public health and environmental conditions in Bien Hoa City would be improved because wastewater would not be spread so easily around your neighborhood and other parts of City.
- The quality of water people obtain from wells might improve because there could be less chance of contamination of groundwater.
- The landscape and natural environment of Bien Hoa City would be improved.

Of course, if households do not connect themselves to the sewer system, then none of the above benefits will be realized, and the investment of the project will be wasted. In order to avoid such a possibility, suppose that the authorities of Bien Hoa put in place an **ACTION PLAN** for all households, including the households in your ward to be connected to the sewer system.

Let me describe to you this Action Plan very briefly. Under this Action Plan, all households in this ward, including yourself, will have the possibility to be connected to the sewer pipe as soon as the sewer pipe is installed.

However, in order to make it easier for you and for other households in your ward to pay for your connection to the sewer pipe, the Action Plan would allow you and other households to pay for the connection by means a monthly payment for a period of 2 years. This monthly payment would be collected from you by a social organization such as the Women Union or another organization. After 2 years, this payment would immediately stop.

SURVEYOR ASK: Is this description clear to you? If NOT clear, repeat the above and/or ask what is not clear. IF YES CLEAR, continue below.

I am now going to ask you about how much your household would be willing to pay to connect your house to the new sewer system and get the wastewater treated instead of being discharged untreated in the rivers and canals of the City and protect the quality of the lake and canals in Bien Hoa City.

There is no right or wrong answer; we simply want to know how much your household would be willing to pay to be connected to the new sewerage system, considering your current income and your other household expenses.

3.2 Suppose that this Action Plan would cost your household nothing at all. Would you vote in favor of the action plan?

① Yes. ② No.

3.3 Please tell me why.

____
____
____
____

CLOSE – ENDED VERSION

3.4. If the monthly payment (<u>for 2 years</u>) of the household were 100,000 VND, would you vote for the action plan to connect to the sewer pipe system?

① Yes ② No 99. I don't know

3.5. What would be the maximum monthly payment for a period of 2 years that your household would be willing to pay? ______________ VND

3.6. How sure are you of this amount (from the above question)?

1	2	3	4	5
Very Uncertain	Moderately Uncertain	Neutral	Moderately Certain	Very Certain

3.7. How much households should pay monthly for their wastewater to be treated?

(VND _________________________________ /Month)

IV. SOCIO-ECONOMIC CHARACTERISTICS

4.1 Gender of respondent: Male Female
4.2 What is your age?______ years
4.3 Are you married? Yes No
4.4 What is the highest level of education that you have completed?
① __ None
② __ Primary school
③ __ Secondary school
④ __ High school
⑤ __ College / University

⑥ __ Postgraduate

4.5 What kind of job(s) do you have? (***List & check all that apply)***

1. Government staff/ staff of a state enterprise
2. Worker/ staff at a private enterprise
3. doing self-business
4. Farmer
5. Don’t work (pensioner, student, housewife etc.)
6. Unemployment
7. Other (please specify_______________________________)

4.6 How many people stay and reside in your household in total (***including yourself***)? ______

4.7 How many adults stay and reside in your household (***18+ years***)? _______

4.8 Please tell me whether this household or any member of it has the following working items:

	Yes	No	
A. Car	1	2	
B. Motorbike	1	2	
C. Internet	1	2	
D. Personal computer		1	2
E. Telephone	1	2	
F. Mobile phone	1	2	
G. Washing machine	1	2	
H. Fridge	1	2	
I. Color television	1	2	
J. Air conditioner	1	2	
K. Gas cooker		1	2

4.9 For your entire household, what were your total expenditures on average per month?

1.	Less than 1 mil VND	11.	From 10 to 11 mil VND
2.	From 1 to 2 mil VND	12.	From 11 to 12 mil VND
3.	From 2 to 3 mil VND	13.	From 12 to 13 mil VND
4.	From 3 to 4 mil VND	14.	From 13 to 14 mil VND
5.	From 4 to 5 mil VND	15.	From 14 to 15 mil VND
6.	From 5 to 6 mil VND	16.	From 15 to 16 mil VND
7.	From 6 to 7 mil VND	17.	From 16 to 17 mil VND
8.	From 7 to 8 mil VND	18.	From 17 to 18 mil VND
9.	From 8 to 9 mil VND	19.	From 18 to 19 mil VND
10.	From 9 to 10 mil VND	20.	More than 19 mil VND

4.10 What is your income on average per month?

1.	Less than 1 mil VND	11.	From 10 to 11 mil VND
2.	From 1 to 2 mil VND	12.	From 11 to 12 mil VND
3.	From 2 to 3 mil VND	13.	From 12 to 13 mil VND
4.	From 3 to 4 mil VND	14.	From 13 to 14 mil VND
5.	From 4 to 5 mil VND	15.	From 14 to 15 mil VND
6.	From 5 to 6 mil VND	16.	From 15 to 16 mil VND
7.	From 6 to 7 mil VND	17.	From 16 to 17 mil VND
8.	From 7 to 8 mil VND	18.	From 17 to 18 mil VND
9.	From 8 to 9 mil VND	19.	From 18 to 19 mil VND
10.	From 9 to 10 mil VND	20.	More than 19 mil VND

4.11 How many people in this household have paid jobs? _____

4.12 For your entire household, what is your total income on average per month?

1.	Less than 1 mil VND	11.	From 10 to 11 mil VND
2.	From 1 to 2 mil VND	12.	From 11 to 12 mil VND
3.	From 2 to 3 mil VND	13.	From 12 to 13 mil VND
4.	From 3 to 4 mil VND	14.	From 13 to 14 mil VND
5.	From 4 to 5 mil VND	15.	From 14 to 15 mil VND
6.	From 5 to 6 mil VND	16.	From 15 to 16 mil VND
7.	From 6 to 7 mil VND	17.	From 16 to 17 mil VND
8.	From 7 to 8 mil VND	18.	From 17 to 18 mil VND
9.	From 8 to 9 mil VND	19.	From 18 to 19 mil VND
10.	From 9 to 10 mil VND	20.	More than 19 mil VND

4.13. Is your household income enough for your family needs?

① No, far from enough for basic needs;
② Just enough for food;
③ Enough for food and clothing
④ Enough for a good quality of life
⑤ With the income, we can have some savings .
Saving approximate ………………………….VND/month
99. Don't know

4.14. How did your total household income change from the year before?

1	2	3	4	5	99
Significantly worsened	Worsened	No change	Improved	Significantly Improved	Don't Know

4.15 How would you describe the quality of your living condition?

1	2	3	4	5	99
Very Bad	Bad	Average	Good	Very good	Don't Know

4.16 Over the next 5 years, how do you think your household's income may change?

1	2	3	4	5	99
Significantly worsened	Worsened	No change	Improved	Significantly Improved	Don't Know

V. INTERVIEWER DEBRIEFING QUESTIONS

5.1. Was the person who answered the questions irritated or nervous during the interview?

Yes No

5.2. Do you think that it was easy for the respondent to answer the questions concerning willingness to pay for the connection to the wastewater pipe.

Yes No ③ NA/Missing

5.3. Was the person who answered the questions looking bored or tired during the interview?

① Yes ② No

5.4. Are you certain that the interviewee was answering to the questions honestly and truly?

1	2	3	4	5	99
Very Uncertain	Moderately Uncertain	Neutral	Moderately Certain	Very Certain	Don't Know

5.5. Who else was listening while you conducted this interview with the respondent? (***Check all that apply***)

① No one
② Spouse
③ Other adult family members
④ Other adults
⑤ Children
⑥ Other (***specify***) ________________________

Time finished: _____ : _____

Note:
Question for payment card version:

- As close – ended version for ever questions except question No.3.4 for payment card version.
- I am going to list to you different monthly payments for a period of 2 year that you would have to pay to connect your household to the sewer pipe. For each monthly payment I am going to suggest to you, please tell me if you would Say Yes for Sure, Probably Say Yes, Probably Say No or Say No for Sure.
- **SURVEYOR ASK**: Is this description clear to you? If NOT clear, repeat the above and/or ask what is not clear. IF YES CLEAR, continue below.

Monthly cost to the household (in VND)	**No for Sure**	**Probably No**	**Not Sure**	**Probably Yes**	**Yes for Sure**
0 (free)	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
25,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
50,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
75,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
100,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
125,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
150,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
175,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
200,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
225,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
250,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
300,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
350,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
400,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
450,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
500,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
600,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
700,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
800,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
900,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
1,000,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%
2,000,000	0%	10% 20% 30% 40%	50%	60% 70% 80% 90%	100%

- SURVEYOR: If the answer is 0% for any amount less than 2,000,000 VND, Go to Question 3.6.
- SURVEYOR: If the answer is greater than 0% for 2,000,000 VND, Go to Question 3.5

Appendix 8-A

Construction Cost Estimate

A Sewer and Drainage Collection Facilities Exchange Rate: 1 VND = 0.00436 Yen

【A1 Sewerage Facilities】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Construction Work						
Interceptor Pipe	38,605,070	110,770,521	149,375,591	651,278		
Main Trunk Sewer	184,627,164	239,920,349	424,547,513	1,851,027		
Branch Sewer	220,423,067	66,126,920	286,549,987	1,249,358		
Tertiary Sewer	711,339,255	213,401,777	924,741,032	4,031,871		
Connection Pipe	79,904,100	23,971,230	103,875,330	452,896		
Overflow Chamber	21,953,518	6,020,700	27,974,219	121,968		
Manhole Type Station for Combined	7,112,736	1,588,091	8,700,828	37,936		
Manhole Type Station for Separate	18,289,894	4,083,664	22,373,557	97,549		
Sub Total (1)	1,282,254,804	665,883,252	1,948,138,057	8,493,882	0	
Equipment and Material						
Overflow Chamber	0	11,750,000	11,750,000	51,230	1,175,000	10.0%
Manhole Type Station for Combined	0	12,250,000	12,250,000	53,410	1,225,000	10.0%
Manhole Type Station for Separate	0	31,500,000	31,500,000	137,340		
Shipping	0	5,550,000	5,550,000	24,198		Equipment Cost ×0.10
Insurance	0	244,200	244,200	1,065		Equipment Cost ×1.1×0.004
Sub Total (2)	0	61,294,200	61,294,200	267,243	2,400,000	
Total	1,282,254,804	727,177,452	2,009,432,257	8,761,125	2,400,000	

【A2 Drainage Facilities】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Main Trunk Sewer for Separate	416,897,525	187,986,994	604,884,519	2,637,297		
Main Trunk Sewer for Combined	104,956,630	50,359,961	155,316,591	677,180		
Branch Sewer for Separate	537,530,000	161,259,000	698,789,000	3,046,720		
Total	1,059,384,155	399,605,955	1,458,990,110	6,361,197	0	

【A3 2.1 Bien Hung Ditch Diversion】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Construction Work						
2.1 Bien Hung Ditch Diversion	27,838,773	288,084,329	315,923,102	1,377,425		
Gate Facilities for 2.1 Bien Hung Ditch	1,918,773	464,329	2,383,102	10,390		
Sub Total (1)	29,757,546	288,548,658	318,306,203	1,387,815		
Equipment and Material						
Gate Facilities for 2.1 Bien Hung Ditch	0	2,500,000	2,500,000	10,900	250,000	10.0%
Shipping	0	250,000	250,000	1,090		Equipment Cost ×0.10
Insurance	0	11,000	11,000	48		Equipment Cost ×1.1×0.004
Sub Total (2)	0	2,761,000	2,761,000	12,038	250,000	
Total	29,757,546	291,309,658	321,067,203	1,399,853	250,000	

【A4 Canal Improvement】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
3.2 Dien Hong Ditch	10,595,000	3,178,500	13,773,500	60,052		
4.1 San Mau Stream	83,440,800	25,032,240	108,473,040	472,942		
4.2 San Mau Stream	62,989,800	18,896,940	81,886,740	357,026		
4.3 San Mau Stream	4,268,000	1,280,400	5,548,400	24,191		
4.4 San Mau Stream	6,924,000	2,077,200	9,001,200	39,245		
4.5 San Mau Stream	19,568,200	5,870,460	25,438,660	110,913		
4.6 San Mau Stream	16,493,200	4,947,960	21,441,160	93,483		
5.1 Linh Bayou Stream	18,512,000	5,553,600	24,065,600	104,926		
5.2 Linh Bayou Stream	14,582,000	4,374,600	18,956,600	82,651		
5. Linh Stream	64,884,200	19,465,260	84,349,460	367,764		
Total	302,257,200	90,677,160	392,934,360	1,713,194		

A1.1 Interceptor Pipe

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
DCIP	Diameter= 100mm	Depth < 2.0m	m	402	3,255,000	976,500	1,308,510	392,553	1,701,063	Main Road
	Diameter= 150mm	Depth < 2.0m	m	785	3,369,000	1,010,700	2,644,665	793,400	3,438,065	Main Road
	Diameter= 200mm	Depth < 2.0m	m	520	3,732,000	1,119,600	1,940,640	582,192	2,522,832	Main Road
PVC	Diameter= 200mm	Depth < 2.0m	m	153	3,771,000	1,131,300	576,963	173,089	750,052	Main Road
	Diameter= 200mm	Depth < 3.0m	m	140	4,962,000	1,488,600	694,680	208,404	903,084	Main Road
HDPE	Diameter= 250mm	Depth < 3.0m	m	485	5,112,000	1,533,600	2,479,320	743,796	3,223,116	Main Road
	Diameter= 280mm	Depth < 4.0m	m	155	11,453,000	3,435,900	1,775,215	532,565	2,307,780	Main Road
	Diameter= 315mm	Depth < 3.0m	m	385	5,983,000	1,794,900	2,303,455	691,037	2,994,492	Main Road
	Diameter= 355mm	Depth < 3.0m	m	120	5,983,000	1,794,900	717,960	215,388	933,348	Main Road
	Diameter= 450mm	Depth < 3.0m	m	370	6,530,000	1,959,000	2,416,100	724,830	3,140,930	Main Road
	Diameter= 450mm	Depth < 5.0m	m	553	12,802,000	3,840,600	7,079,506	2,123,852	9,203,358	Main Road
RC	Diameter= 900mm	Depth < 5.0m	m	373	14,472,000	4,341,600	5,398,056	1,619,417	7,017,473	Main Road
	Diameter= 900mm	Depth < 6.0m Pipe Jacking	m	370	5,000,000	55,000,000	1,850,000	20,350,000	22,200,000	Main Road
	Diameter= 900mm	Depth < 7.0m Pipe Jacking	m	290	5,000,000	55,000,000	1,450,000	15,950,000	17,400,000	Main Road
	Diameter= 900mm	Depth < 8.0m Pipe Jacking	m	979	5,000,000	55,000,000	4,895,000	53,845,000	58,740,000	Main Road
	Diameter= 900mm	Depth < 10m Pipe Jacking	m	215	5,000,000	55,000,000	1,075,000	11,825,000	12,900,000	Main Road
Total				6,295			38,605,070	110,770,521	149,375,591	

A1.2 Main Trunk Sewer

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
DCIP	Diameter= 200mm	Depth < 2.0m	m	914	3,732,000	1,119,600	3,411,048	1,023,314	4,434,362	Main Road
PVC	Diameter= 400mm	Depth < 3.0m	m	385	5,983,000	1,794,900	2,303,455	691,037	2,994,492	Main Road
	Diameter= 400mm	Depth < 4.0m	m	247	11,928,000	3,578,400	2,946,216	883,865	3,830,081	Main Road
	Diameter= 500mm	Depth < 3.0m	m	765	6,530,000	1,959,000	4,995,450	1,498,635	6,494,085	Main Road
	Diameter= 500mm	Depth < 5.0m	m	590	12,802,000	3,840,600	7,553,180	2,265,954	9,819,134	Main Road
	Diameter= 630mm	Depth < 4.0m	m	556	14,495,000	4,348,500	8,059,220	2,417,766	10,476,986	Main Road
HDPE	Diameter= 710mm	Depth < 3.0m	m	322	13,964,000	4,189,200	4,496,408	1,348,922	5,845,330	Main Road
	Diameter= 800mm	Depth < 4.0m	m	140	22,278,000	6,683,400	3,118,920	935,676	4,054,596	Main Road
	Diameter= 900mm	Depth < 4.0m	m	1,340	25,612,000	7,683,600	34,320,080	10,296,024	44,616,104	Main Road
	Diameter= 900mm	Depth < 5.0m	m	1,041	26,080,000	7,824,000	27,149,280	8,144,784	35,294,064	Main Road
	Diameter= 1200mm	Depth < 5.0m	m	1,214	36,671,000	11,001,300	44,518,594	13,355,578	57,874,172	Main Road
RC	Diameter= 900mm	Depth < 4.0m	m	495	12,559,000	3,767,700	6,216,705	1,865,012	8,081,717	Main Road
	Diameter= 900mm	Depth < 5.0m	m	1,264	14,472,000	4,341,600	18,292,608	5,487,782	23,780,390	Main Road
	Diameter= 900mm	Depth < 7.0m Pipe Jacking	m	500	5,000,000	55,000,000	2,500,000	27,500,000	30,000,000	Main Road
	Diameter= 1200mm	Depth < 7.0m Pipe Jacking	m	752	6,000,000	66,000,000	4,512,000	49,632,000	54,144,000	Main Road
	Diameter= 1500mm	Depth < 8.0m Pipe Jacking	m	837	7,000,000	77,000,000	5,859,000	64,449,000	70,308,000	Main Road
	Diameter= 1500mm	Depth < 9.0m Pipe Jacking	m	625	7,000,000	77,000,000	4,375,000	48,125,000	52,500,000	Main Road
Total				11,987			184,627,164	239,920,349	424,547,513	

A1.3 Branch Sewer

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
PVC	Diameter= 200mm	Depth < 3.0m	m	792	4,962,000	1,488,600	3,929,904	1,178,971	5,108,875	Main Road
	Diameter= 225mm	Depth < 3.0m	m	17,757	5,112,000	1,533,600	90,773,784	27,232,135	118,005,919	Main Road
	Diameter= 250mm	Depth < 3.0m	m	15,876	5,112,000	1,533,600	81,158,112	24,347,434	105,505,546	Main Road
	Diameter= 280mm	Depth < 3.0m	m	6,689	5,376,000	1,612,800	35,960,064	10,788,019	46,748,083	Main Road
	Diameter= 280mm	Depth < 4.0m	m	751	11,453,000	3,435,900	8,601,203	2,580,361	11,181,564	Main Road
Total				41,865			220,423,067	66,126,920	286,549,987	

A1.4 Tertiary Sewer

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
PVC	Diameter= 200mm	Depth < 2.0m	m	101,850	3,213,000	963,900	327,244,050	98,173,215	425,417,265	Side Walk
PVC	Diameter= 200mm	Depth < 2.0m	m	101,855	3,771,000	1,131,300	384,095,205	115,228,562	499,323,767	Main Road
Total				203,705			711,339,255	213,401,777	924,741,032	

A1.5 Others

Items	Specification	Unit	Quantity	Unit Cost (1,000VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Connection Pipe	Construction	set	24,900	3,209	963	79,904,100	23,971,230	103,875,330	
Overflow Chamber	Construction	set	22	997,887	273,668	21,953,518	6,020,700	27,974,219	
	Material	set	20	0	587,500	0	11,750,000	11,750,000	
Manhole Type Pump Station for Combined	Construction	set	7	1,016,105	226,870	7,112,736	1,588,091	8,700,828	
	Material	set	7	0	1,750,000	0	12,250,000	12,250,000	
Manhole Type Pump Station for Separate	Construction	set	18	1,016,105	226,870	18,289,894	4,083,664	22,373,557	
	Material	set	18	0	1,750,000	0	31,500,000	31,500,000	
Total						127,260,248	91,163,685	218,423,934	

A2.1 Main Trunk Sewer for Separate

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
RC	Diameter= 600mm	Depth < 2.0m	m	3,020	3,960,000	1,188,000	11,959,200	3,587,760	15,546,960	Side Walk
	Diameter= 800mm	Depth < 2.0m	m	6,590	4,213,000	1,263,900	27,763,670	8,329,101	36,092,771	Side Walk
	Diameter= 1000mm	Depth < 2.0m	m	12,170	5,607,000	1,682,100	68,237,190	20,471,157	88,708,347	Main Road
	Diameter= 1000mm	Depth < 3.0m	m	570	6,749,000	2,024,700	3,846,930	1,154,079	5,001,009	Main Road
	Diameter= 1200mm	Depth < 2.0m	m	4,335	6,596,000	1,978,800	28,593,660	8,578,098	37,171,758	Main Road
	Diameter= 1200mm	Depth < 3.0m	m	5,235	7,845,000	2,353,500	41,068,575	12,320,573	53,389,148	Main Road
	Diameter= 1500mm	Depth < 3.0m	m	6,105	9,132,000	2,739,600	55,750,860	16,725,258	72,476,118	Main Road
	Diameter= 1800mm	Depth < 2.0m	m	40	10,553,000	3,165,900	422,120	126,636	548,756	Main Road
	Diameter= 1800mm	Depth < 3.0m	m	3,985	10,553,000	3,165,900	42,053,705	12,616,112	54,669,817	Main Road
	Diameter= 2000mm	Depth < 3.0m	m	1,670	11,367,000	3,410,100	18,982,890	5,694,867	24,677,757	Main Road
RC Culvert	2000×2000	Depth < 3.0m	m	1,175	70,231,920	58,815,520	82,522,506	69,108,236	151,630,742	Main Road
	2500×2500	Depth < 4.0m	m	375	72,529,920	59,527,520	27,198,720	22,322,820	49,521,540	Main Road
	3000×3000	Depth < 4.0m	m	105	80,928,560	66,212,360	8,497,499	6,952,298	15,449,797	Main Road
Total				45,375			416,897,525	187,986,994	604,884,519	

A2.2 Main Trunk Sewer for Combined

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
RC	Diameter= 600mm	Depth < 2.0m	m	655	3,960,000	1,188,000	2,593,800	778,140	3,371,940	Side Walk
	Diameter= 800mm	Depth < 2.0m	m	1,430	4,213,000	1,263,900	6,024,590	1,807,377	7,831,967	Side Walk
	Diameter= 1000mm	Depth < 2.0m	m	2,640	5,607,000	1,682,100	14,802,480	4,440,744	19,243,224	Main Road
	Diameter= 1200mm	Depth < 2.0m	m	1,220	6,596,000	1,978,800	8,047,120	2,414,136	10,461,256	Main Road
	Diameter= 1200mm	Depth < 3.0m	m	795	7,845,000	2,353,500	6,236,775	1,871,033	8,107,808	Main Road
	Diameter= 1500mm	Depth < 2.0m	m	135	9,132,000	2,739,600	1,232,820	369,846	1,602,666	Main Road
	Diameter= 1500mm	Depth < 3.0m	m	525	9,132,000	2,739,600	4,794,300	1,438,290	6,232,590	Main Road
	Diameter= 1800mm	Depth < 2.0m	m	120	10,553,000	3,165,900	1,266,360	379,908	1,646,268	Main Road
	Diameter= 1800mm	Depth < 3.0m	m	1,250	10,553,000	3,165,900	13,191,250	3,957,375	17,148,625	Main Road
	Diameter= 2000mm	Depth < 3.0m	m	1,025	11,367,000	3,410,100	11,651,175	3,495,353	15,146,528	Main Road
RC Culvert	2000×2000	Depth < 3.0m	m	350	70,231,920	58,815,520	24,581,172	20,585,432	45,166,604	Main Road
	2000×2000	Depth < 4.0m	m	150	70,231,920	58,815,520	10,534,788	8,822,328	19,357,116	Main Road
Total				10,295			104,956,630	50,359,961	155,316,591	

A2.3 Branch Sewer for Separate

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
RC	Diameter= 500mm	Depth < 2.0m	m	55,000	4,550,000	1,365,000	250,250,000	75,075,000	325,325,000	Side Walk
	Diameter= 500mm	Depth < 2.0m	m	56,000	5,130,000	1,539,000	287,280,000	86,184,000	373,464,000	Main Road
Total				111,000			537,530,000	161,259,000	698,789,000	

A3.1 2.1 Bien Hung Ditch Diversion

Items	Specification(1)	Specification(2)	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
					LC	FC	LC	FC	Total	
RC pipe	Diameter= 2300mm	Depth > 5.0m Pipe Jacking	m	2,160	12,000,000	132,000,000	25,920,000	285,120,000	311,040,000	Main Road
Gate		Construction	set	2	959,386	232,164	1,918,773	464,329	2,383,102	
		Material	set	2	0	1,250,000	0	2,500,000	2,500,000	
Total							27,838,773	288,084,329	315,923,102	

A4.1 Canal Improvement

Items	Specification	Unit	Quantity	Unit Cost (1,000VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
3.2 Dien Hong Ditch	Dredging and Embankment	set	1	10,595,000	3,178,500	10,595,000	3,178,500	13,773,500	
4.1 San Mau Stream	Dredging and Embankment	set	1	68,862,000	20,658,600	68,862,000	20,658,600	89,520,600	
	Bridge Construction	set	1	14,578,800	4,373,640	14,578,800	4,373,640	18,952,440	
	Sub-Total					83,440,800	25,032,240	108,473,040	
4.2 San Mau Stream	Dredging and Embankment	set	1	60,599,000	18,179,700	60,599,000	18,179,700	78,778,700	
	Bridge Construction	set	1	2,390,800	717,240	2,390,800	717,240	3,108,040	
	Sub-Total					62,989,800	18,896,940	81,886,740	
4.3 San Mau Stream	Dredging and Embankment	set	1	4,218,000	1,265,400	4,218,000	1,265,400	5,483,400	
	Bridge Construction	set	1	50,000	15,000	50,000	15,000	65,000	
	Sub-Total					4,268,000	1,280,400	5,548,400	
4.4 San Mau Stream	Dredging and Embankment	set	1	6,924,000	2,077,200	6,924,000	2,077,200	9,001,200	
4.5 San Mau Stream	Dredging and Embankment	set	1	17,941,000	5,382,300	17,941,000	5,382,300	23,323,300	
	Bridge Construction	set	1	1,627,200	488,160	1,627,200	488,160	2,115,360	
	Sub-Total					19,568,200	5,870,460	25,438,660	
4.6 San Mau Stream	Dredging and Embankment	set	1	12,849,000	3,854,700	12,849,000	3,854,700	16,703,700	
	Bridge Construction	set	1	3,644,200	1,093,260	3,644,200	1,093,260	4,737,460	
	Sub-Total					16,493,200	4,947,960	21,441,160	
5.1 Linh Bayou Stream	Dredging and Embankment	set	1	15,328,000	4,598,400	15,328,000	4,598,400	19,926,400	
	Bridge Construction	set	1	3,184,000	955,200	3,184,000	955,200	4,139,200	
	Sub-Total					18,512,000	5,553,600	24,065,600	
5.2 Linh Bayou Stream	Dredging and Embankment	set	1	13,832,000	4,149,600	13,832,000	4,149,600	17,981,600	
	Bridge Construction	set	1	750,000	225,000	750,000	225,000	975,000	
	Sub-Total					14,582,000	4,374,600	18,956,600	
5. Linh Stream	Dredging and Embankment	set	1	62,440,000	18,732,000	62,440,000	18,732,000	81,172,000	
	Bridge Construction	set	1	2,444,200	733,260	2,444,200	733,260	3,177,460	
	Sub-Total					64,884,200	19,465,260	84,349,460	
Total						302,257,200	90,677,160	392,934,360	

B STP and PS Cost Exchange Rate: 1 VND = 0.00436 Yen

【B1 Pumping Station-1】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Construction Work						
Pumping Station-1	22,752,190	6,902,993	29,655,183	129,297		
Mechanical Instration	2,702,000		2,702,000	11,781		
Elctrical Instration	2,095,000		2,095,000	9,134		
Sub Total (1)	27,549,190	6,902,993	34,452,183	150,212	0	
Equipment and Material						
Mechanical Equipment		27,022,000	27,022,000	117,816	2,702,200	10.0%
Elctrical Equipment		11,777,000	11,777,000	51,348	588,850	5.0%
Shipping		3,879,900	3,879,900	16,916		Equipment Cost ×0.10
Insurance		170,716	170,716	744		Equipment Cost ×1.1×0.004
Sub Total (2)	0	42,849,616	42,849,616	186,824	3,291,050	
Total	27,549,190	49,752,609	77,301,799	337,036	3,291,050	

【B2 Pumping Station-5】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Construction Work						
Pumping Station-5	34,414,317	10,372,625	44,786,942	195,271		
Mechanical Instration	3,574,000	0	3,574,000	15,583		
Elctrical Instration	1,875,000	0	1,875,000	8,175		
Sub Total (1)	39,863,317	10,372,625	50,235,942	219,029	0	
Equipment and Material						
Mechanical Equipment		35,742,000	35,742,000	155,835	3,574,200	10.0%
Elctrical Equipment		18,751,000	18,751,000	81,754	937,550	5.0%
Shipping		5,449,300	5,449,300	23,759		Equipment Cost ×0.10
Insurance		239,769	239,769	1,045		Equipment Cost ×1.1×0.004
Sub Total (2)	0	60,182,069	60,182,069	262,394	4,511,750	
Total	39,863,317	70,554,694	110,418,011	481,423	4,511,750	

【B3 Primary Site Work for STP2】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Primary Site Work for STP2	21,590,500	6,587,500	28,178,000	122,856		

【B4 STP2】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Construction Work						
Secondary Site Work for STP2	24,561,000	7,406,000	31,967,000	139,376		
CAS Facilities	273,233,108	82,189,051	355,422,159	1,549,641		
UV Disinfection	5,658,250	1,702,245	7,360,495	32,092		
Sludge Thickener and Pump Building	16,038,654	4,824,079	20,862,733	90,962		
Sludge Treatment Building	70,019,847	21,040,292	91,060,139	397,022		
Blower Building	7,085,720	2,125,716	9,211,436	40,162		
Administration Building	49,103,080	12,485,232	61,588,312	268,525		
Garage and Workshops	12,979,600	3,148,188	16,127,788	70,317		
Outlet	3,331,772	1,000,029	4,331,800	18,887		
Mechanical Instration	56,036,000	0	56,036,000	244,317		
Elctrical Instration	26,187,000	0	26,187,000	114,175		
EIA Monitoring	1,148,280	344,484	1,492,764	6,508		
Sub Total (1)	545,382,311	136,265,316	681,647,626	2,971,984		
Equipment and Material						
Primary Sedimentation Tank		60,784,000	60,784,000	265,018	3,039,200	5.0%
Reactor Tank		78,257,000	78,257,000	341,201	3,912,850	5.0%
Final Sedimentation Tank		128,871,000	128,871,000	561,878	6,443,550	5.0%
UV Disinfection		60,646,000	60,646,000	264,417	3,032,300	5.0%
Sludge Thickener		23,442,000	23,442,000	102,207	1,172,100	5.0%
Dewatering Facilities		200,139,000	200,139,000	872,606	10,006,950	5.0%
Odor control Facilities		7,303,000	7,303,000	31,841	365,150	5.0%
Outlet		917,000	917,000	3,998	91,700	10.0%
Electrical Equipment		225,173,000	225,173,000	981,754	11,258,650	5.0%
Shipping		78,553,200	78,553,200	342,492		Equipment Cost ×0.10
Insurance		3,456,341	3,456,341	15,070		Equipment Cost ×1.1×0.004
Sub Total (2)	0	867,541,541	867,541,541	3,782,481	39,322,450	
Total	545,382,311	1,003,806,857	1,549,189,167	6,754,465	39,322,450	

【B5 Management and Maintenance Equipment】

Item	VND (×1,000)			Yen (×1,000)	Custom Duty	Remark
	LC	FC	Total	Total	VND (×1,000)	
Vehicles		144,954,000	144,954,000	631,999	144,954,000	100.0%
Maintenance Equipments		6,330,000	6,330,000	27,599	316,500	5.0%
Shipping		15,128,400	15,128,400	65,960		Equipment Cost ×0.10
Insurance		665,650	665,650	2,902		Equipment Cost ×1.1×0.004
Total	0	167,078,050	167,078,050	728,460	145,270,500	

B1.1 PS-1 and Site Work

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Excavation		m^3	28,400	29,000	9,000	823,600	255,600	1,079,200	
Transport for Back Filling		m^3	28,400	34,000	11,000	965,600	312,400	1,278,000	
Back Filling		m^3	24,700	45,000	14,000	1,111,500	345,800	1,457,300	
Transport for Back Filling		m^3	27,100	34,000	11,000	921,400	298,100	1,219,500	
Transport for Disposal		m^3	1,300	34,000	11,000	44,200	14,300	58,500	
Soil Improvement		m^3	800	565,000	170,000	452,000	136,000	588,000	
Gravel		m^3	60	179,000	54,000	10,740	3,240	13,980	
Ieveling Concrete		m^3	30	3,636,000	1,091,000	109,080	32,730	141,810	
Reinforced Concrete		m^3	2,000	3,636,000	1,091,000	7,272,000	2,182,000	9,454,000	
Reinforcement		t	240	17,520,000	5,256,000	4,204,800	1,261,440	5,466,240	
Rebar Fabrication and Assembly		t	240	1,752,000	526,000	420,480	126,240	546,720	
Formwork		m^2	5,200	114,000	35,000	592,800	182,000	774,800	
Scaffolding		m^2	1,700	227,000	69,000	385,900	117,300	503,200	
Supporting		m^3	3,200	364,000	110,000	1,164,800	352,000	1,516,800	
Protectiong Coartiong		m^2	1,000	1,200,000	360,000	1,200,000	360,000	1,560,000	
Fixtures and Fittings		set	1	2,304,090,000	692,543,000	2,304,090	692,543	2,996,633	Total cost 15%
Fence		m	300	627,000	189,000	188,100	56,700	244,800	
Road	Pavement	m^2	500	565,000	170,000	282,500	85,000	367,500	
Drainage	D=300mm	m	50	3,772,000	1,132,000	188,600	56,600	245,200	
Eectric Lamp		m^3	3	20,000,000	6,000,000	60,000	18,000	78,000	
Lawn Grass		m^3	5,000	10,000	3,000	50,000	15,000	65,000	
Total						22,752,190	6,902,993	29,655,183	

B2.1 PS-5

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Excavation		m^3	39,200	29,000	9,000	1,136,800	352,800	1,489,600	
Back Filling		m^3	30,700	45,000	14,000	1,381,500	429,800	1,811,300	
Soil Improvement		m^3	1,600	565,000	170,000	904,000	272,000	1,176,000	
Gravel		m^3	140	179,000	54,000	25,060	7,560	32,620	
Ieveling Concrete		m^3	70	3,636,000	1,091,000	254,520	76,370	330,890	
Reinforced Concrete		m^3	3,300	3,636,000	1,091,000	11,998,800	3,600,300	15,599,100	
Reinforcement		t	400	17,520,000	5,256,000	7,008,000	2,102,400	9,110,400	
Rebar Fabrication and Assembly		t	400	1,752,000	526,000	700,800	210,400	911,200	
Formwork		m^2	8,800	114,000	35,000	1,003,200	308,000	1,311,200	
Scaffolding		m^2	2,400	227,000	69,000	544,800	165,600	710,400	
Supporting		m^3	9,600	364,000	110,000	3,494,400	1,056,000	4,550,400	
Protectiong Coartiong		m^2	1,600	1,200,000	360,000	1,920,000	576,000	2,496,000	
Fixtures and Fittings		set	1	4,042,437,000	1,215,395,000	4,042,437	1,215,395	5,257,832	Total cost 15%
Total						34,414,317	10,372,625	44,786,942	

B3.1 Primary Site Work forr STP2

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Demolition and Dredging	Suface structure	m^3	7,500	265,000	80,000	1,987,500	600,000	2,587,500	
Demolished Materilal Transport		m^3	7,500	34,000	11,000	255,000	82,500	337,500	
Demolished Materilal Disposal		m^3	7,500	80,000	24,000	600,000	180,000	780,000	
Discharge by Pump		m^3	50,000	5,000	2,000	250,000	100,000	350,000	
Primary Landfilling	Backfilling by purchase Soil	m^3	189,000	82,000	25,000	15,498,000	4,725,000	20,223,000	
Wall		m	600	5,000,000	1,500,000	3,000,000	900,000	3,900,000	Housing Side
Total						21,590,500	6,587,500	28,178,000	

B4.1 Secondary Site Work for STP2

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Secondary Landfilling		m^3	63,000	36,000	11,000	2,268,000	693,000	2,961,000	
Secondary Landfilling	Backfilling by purchase Soil	m^3	47,000	82,000	25,000	3,854,000	1,175,000	5,029,000	
Wall		m	600	5,000,000	1,500,000	3,000,000	900,000	3,900,000	River Side
Road	Pavement	m^2	11,000	565,000	170,000	6,215,000	1,870,000	8,085,000	
Drainage	D=300mm	m	1,300	3,772,000	1,132,000	4,903,600	1,471,600	6,375,200	
Eectric Lamp		pole	60	20,000,000	6,000,000	1,200,000	360,000	1,560,000	
Lawn Grass		m^3	48,000	10,000	3,000	480,000	144,000	624,000	
Yard Pipe		m	700	3,772,000	1,132,000	2,640,400	792,400	3,432,800	
Total						24,561,000	7,406,000	31,967,000	

B4.2 CAS Facilities

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Excavation		m^3	83,200	29,000	9,000	2,412,800	748,800	3,161,600	
Back Filling		m^3	27,700	45,000	14,000	1,246,500	387,800	1,634,300	
Soil Improvement		m^3	45,300	565,000	170,000	25,594,500	7,701,000	33,295,500	
Gravel		m^3	1,300	179,000	54,000	232,700	70,200	302,900	
Ieveling Concrete		m^3	650	3,636,000	1,091,000	2,363,400	709,150	3,072,550	
Reinforced Concrete		m^3	27,600	3,636,000	1,091,000	100,353,600	30,111,600	130,465,200	
Reinforcement		t	3,310	17,520,000	5,256,000	57,991,200	17,397,360	75,388,560	
Rebar Fabrication and Assembly		t	3,310	1,752,000	526,000	5,799,120	1,741,060	7,540,180	
Formwork		m^2	66,000	114,000	35,000	7,524,000	2,310,000	9,834,000	
Scaffolding		m^2	8,500	227,000	69,000	1,929,500	586,500	2,516,000	
Supporting		m^3	86,600	364,000	110,000	31,522,400	9,526,000	41,048,400	
Protectiong Coartiong		m^2	3,700	1,200,000	360,000	4,440,000	1,332,000	5,772,000	
Fixtures and Fittings		set	1	31,823,388,000	9,567,581,000	31,823,388	9,567,581	41,390,969	Total cost 15%
Total						273,233,108	82,189,051	355,422,159	

B4.3 UV Disinfection

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Excavation		m^3	1,100	29,000	9,000	31,900	9,900	41,800	
Back Filling		m^3	600	45,000	14,000	27,000	8,400	35,400	
Soil Improvement		m^3	2,300	565,000	170,000	1,299,500	391,000	1,690,500	
Gravel		m^3	40	179,000	54,000	7,160	2,160	9,320	
Ieveling Concrete		m^3	20	3,636,000	1,091,000	72,720	21,820	94,540	
Reinforced Concrete		m^3	500	3,636,000	1,091,000	1,818,000	545,500	2,363,500	
Reinforcement		t	60	17,520,000	5,256,000	1,051,200	315,360	1,366,560	
Rebar Fabrication and Assembly		t	60	1,752,000	526,000	105,120	31,560	136,680	
Formwork		m^2	1,300	114,000	35,000	148,200	45,500	193,700	
Scaffolding		m^2	600	227,000	69,000	136,200	41,400	177,600	
Supporting		m^3	1,100	364,000	110,000	400,400	121,000	521,400	
Fixtures and Fittings		set	1	560,850,000	168,645,000	560,850	168,645	729,495	Total cost 15%
Total						5,658,250	1,702,245	7,360,495	

B4.4 Sludge Thickener

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Excavation		m^3	3,400	29,000	9,000	98,600	30,600	129,200	
Back Filling		m^3	1,900	45,000	14,000	85,500	26,600	112,100	
Soil Improvement		m^3	6,600	565,000	170,000	3,729,000	1,122,000	4,851,000	
Gravel		m^3	120	179,000	54,000	21,480	6,480	27,960	
Ieveling Concrete		m^3	60	3,636,000	1,091,000	218,160	65,460	283,620	
Reinforced Concrete		m^3	1,300	3,636,000	1,091,000	4,726,800	1,418,300	6,145,100	
Reinforcement		t	160	17,520,000	5,256,000	2,803,200	840,960	3,644,160	
Rebar Fabrication and Assembly		t	160	1,752,000	526,000	280,320	84,160	364,480	
Formwork		m^2	3,100	114,000	35,000	353,400	108,500	461,900	
Scaffolding		m^2	1,400	227,000	69,000	317,800	96,600	414,400	
Supporting		m^3	2,700	364,000	110,000	982,800	297,000	1,279,800	
Protectiong Coartiong		m^2	700	1,200,000	360,000	840,000	252,000	1,092,000	
Fixtures and Fittings		set	1	1,581,594,000	475,419,000	1,581,594	475,419	2,057,013	Total cost 15%
Total						16,038,654	4,824,079	20,862,733	

B4.5 Sludge Treatment Building

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Excavation		m^3	5,200	29,000	9,000	150,800	46,800	197,600	
Back Filling		m^3	2,200	45,000	14,000	99,000	30,800	129,800	
Foundation Pile	400x400, L=10m	pcs	530	11,990,000	3,597,000	6,354,700	1,906,410	8,261,110	
Gravel		m^3	320	179,000	54,000	57,280	17,280	74,560	
Ieveling Concrete		m^3	160	3,636,000	1,091,000	581,760	174,560	756,320	
Reinforced Concrete		m^3	7,700	3,636,000	1,091,000	27,997,200	8,400,700	36,397,900	
Reinforcement		t	920	17,520,000	5,256,000	16,118,400	4,835,520	20,953,920	
Rebar Fabrication and Assembly		t	920	1,752,000	526,000	1,611,840	483,920	2,095,760	
Formwork		m^2	13,000	114,000	35,000	1,482,000	455,000	1,937,000	
Scaffolding		m^2	2,300	227,000	69,000	522,100	158,700	680,800	
Supporting		m^3	16,300	364,000	110,000	5,933,200	1,793,000	7,726,200	
Protectiong Coartiong		m^2	700	1,200,000	360,000	840,000	252,000	1,092,000	
Fixtures and Fittings		set	1	8,271,567,000	2,485,602,000	8,271,567	2,485,602	10,757,169	Total cost 15%
Total						70,019,847	21,040,292	91,060,139	

B4.6 Blower Building

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Building Construction		m^2	450	15,000,000	4,500,000	6,750,000	2,025,000	8,775,000	
Foundation Pile	400x400, L=10m	pcs	28	11,990,000	3,597,000	335,720	100,716	436,436	
Total						7,085,720	2,125,716	9,211,436	

A4.7 Administration Building

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Building Construction		m^2	2,700	15,000,000	4,500,000	40,500,000	12,150,000	52,650,000	
Foundation Pile	400x400, L=10m	pcs	92	11,990,000	3,597,000	1,103,080	330,924	1,434,004	
Laboratory Equipment		set	1	7,500,000,000	4,308,000	7,500,000	4,308	7,504,308	
Total						49,103,080	12,485,232	61,588,312	

B4.8 Garage and Workshops

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Building Construction		m^2	1,000	10,000,000	3,000,000	10,000,000	3,000,000	13,000,000	
Foundation Pile	400x400, L=10m	pcs	40	11,990,000	3,597,000	479,600	143,880	623,480	
Equipments for Repair and Maintenance		set	1	2,500,000,000	4,308,000	2,500,000	4,308	2,504,308	
Total						12,979,600	3,148,188	16,127,788	

B4.9 Outlet

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Excavation		m^3	400	29,000	9,000	11,600	3,600	15,200	
Back Filling		m^3	350	45,000	14,000	15,750	4,900	20,650	
Steel Sheet Pile Driving		pcs	148	1,440,000	432,000	213,120	63,936	277,056	
Steel Sheet Pile Removing		pcs	148	962,000	289,000	142,376	42,772	185,148	
Steel Sheet Pile Lease		t	113	6,000,000	1,800,000				
Soil Improvement		m^3	50	565,000	170,000	28,250	8,500	36,750	
Gravel		m^3	4	179,000	54,000	716	216	932	
Ieveling Concrete		m^3	2	3,636,000	1,091,000	7,272	2,182	9,454	
Reinforced Concrete		m^3	15	3,636,000	1,091,000	54,540	16,365	70,905	
Reinforcement		t	2	17,520,000	5,256,000	31,536	9,461	40,997	
Rebar Fabrication and Assembly		t	2	1,752,000	526,000	3,154	947	4,100	
Formwork		m^2	60	114,000	35,000	6,840	2,100	8,940	
Scaffolding		m^2	70	227,000	69,000	15,890	4,830	20,720	
Supporting		m^3	2	364,000	110,000	728	220	948	
Bank Protection		m	40	70,000,000	21,000,000	2,800,000	840,000	3,640,000	
Total						3,331,772	1,000,029	4,331,800	

B4.10 EIA

Items	Specification	Unit	Quantity	Unit Cost (VND)		Total Cost (1,000VND)			Reference
				LC	FC	LC	FC	Total	
Construction Period Environmental Monitering		years	5	229,656,000	68,896,800	1,148,280	344,484	1,492,764	
Total						1,148,280	344,484	1,492,764	

Mechanical and Electrical Cost

(10%) (Unit: Japanese Yen*1,000)

Item	Equipment		Installation		Custom Duty	
	Mechanical	Electirical	Mechanical	Electirical	Ratio	Duty
Pumping Station-1	117,818	35,346	11,782	3,535	10.0%	15,316
Connecting Electric Cable for PS-1				4,000		
Power Generator (80kVA)		16,000	0	1,600	5.0%	800
Pumping Station-5	155,835	46,751	15,584	4,675	10.0%	20,259
Primary Sedimentation Tank	265,018	79,506	26,502	7,951	5.0%	17,226
Reactor Tank	341,202	102,361	34,120	10,236	5.0%	22,178
Final Sedimentation Tank	561,878	168,564	56,188	16,856	5.0%	36,522
UV Disinfection	264,418	79,326	26,442	7,933	5.0%	17,187
Sludge Thickener	102,206	30,662	10,221	3,066	5.0%	6,643
Dewatering Facilities	872,606	261,782	87,261	26,178	5.0%	56,719
Odor control Facilities	31,840	9,552	3,184	955	5.0%	2,070
Outlet	4,000		400		5.0%	200
Vehicles	632,000				100.0%	632,000
Maintenance Equipments	27,600				5.0%	1,380
Connecting Electric Cable for STP2				16,000		
Power Generator (200kVA)		35,000		3,500	5.0%	1,750
Power Generator (500kVA)		50,000		5,000	5.0%	2,500
Scada System		200,000		20,000	5.0%	10,000
Total	3,376,421	1,114,850	271,684	131,485		842,750
Pumping Station-1 Total	117,818	51,346	11,782	9,135		16,116
STP2 Total	3,258,603	1,063,504	259,902	122,350		826,634

Exchange Rate: 1 VND = 0.00436 Yen

(Unit: VND*1,000)

Item	Equipment		Installation		Custom Duty	
	Mechanical	Electirical	Mechanical	Electirical	Ratio	Duty
Pumping Station-1	27,022,000	8,107,000	2,702,000	811,000	10.0%	3,512,900
Connecting Electric Cable for PS-1	0	0	0	917,000		0
Power Generator (80kVA)	0	3,670,000	0	367,000	5.0%	183,500
Pumping Station-5	35,742,000	10,723,000	3,574,000	1,072,000	10.0%	4,646,500
Power Generator (200kVA)	0	8,028,000	0	803,000	5.0%	401,400
Primary Sedimentation Tank	60,784,000	18,235,000	6,078,000	1,824,000	5.0%	3,950,950
Reactor Tank	78,257,000	23,477,000	7,826,000	2,348,000	5.0%	5,086,700
Final Sedimentation Tank	128,871,000	38,661,000	12,887,000	3,866,000	5.0%	8,376,600
UV Disinfection	60,646,000	18,194,000	6,065,000	1,819,000	5.0%	3,942,000
Sludge Thickener	23,442,000	7,033,000	2,344,000	703,000	5.0%	1,523,750
Dewatering Facilities	200,139,000	60,042,000	20,014,000	6,004,000	5.0%	13,009,050
Odor control Facilities	7,303,000	2,191,000	730,000	219,000	5.0%	474,700
Outlet	917,000	0	92,000	0	5.0%	45,850
Connecting Electric Cable for STP2	0	0	0	3,670,000		
Power Generator (500kVA)	0	11,468,000	0	1,147,000	5.0%	573,400
Scada System	0	45,872,000	0	4,587,000	5.0%	2,293,600
Vehicles	144,954,000	0	0	0	100.0%	144,954,000
Maintenance Equipments	6,330,000	0	0	0	5.0%	316,500
Total	774,407,000	255,701,000	62,312,000	30,157,000		193,291,400
Pumping Station-1 Total	27,022,000	11,777,000	2,702,000	2,095,000		3,696,400
Pumping Station-5 Total	35,742,000	18,751,000	3,574,000	1,875,000		5,047,900
STP2 Total	560,359,000	225,173,000	56,036,000	26,187,000		39,276,600

1 Main Pump Station-1

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M1 001	Inlet Gate	Motor Operated Cast Iron Gate W500mm x H700mm	0.75 kw	3	units	1,600	4,800
M1 002	Corase Screen	Bar Screen (manual raking) W1.0m x H3.1m x O.P. 100mm		3	units	280	840
M1 003	Fine Automatic Bar Screen	Disintergrator with Automatic Bar Screen W1.0m x H3.1m x O.P. 20mm	2.2 kW	2	units	14,400	28,800
M1 004	Fine Bar Screen	Bar Screen (SUS304) W1.0m x H3.1m x O.P. 20mm		1	units	640	640
M1 005	Screening Washer whis Conveyer		1.5 kW	1	units	2,800	3,500
M1 006	Grit Collector	Chamber Area = 2m x 4m	2.2 kW	2	units	9,600	19,200
M1 007	Grit Washer with Container		3.7 kW	1	unit	12,000	15,000
M1 008	Submersible Pump	φ300mm x 8.6m3/min x 12m (stand-by 2)	30 kW	4	units	3,360	13,440
M1 009	Mixer	Submersible Mixer	3.7 kW	2	units	1,200	2,400
M1 010	Pump Well connection Gate	Manual Operated W400mm x H400mm		1	unit	520	650
M1 011	Discharge Valve	Electrical Motor Operation φ250mm	0.75 kW	4	units	960	3,840
M1 012	Hoist Block for Pump	Geared Trolley Chain Block 2.0ton x 10m	0.4 kW	1	unit	320	400
M1 013	Hoist Block for Cartridge 1	Geared Trolley Chain Block 1.0ton x 10m	0.2 kW	1	unit	280	350
M1 014	Hoist Block for Cartridge 2	Geared Trolley Chain Block 1.0ton x 3.5m	0.2 kW	1	unit	280	350
M1 015	Pump Station Odor Control Fan	FRP tubo fan 50.0m^3/min	1.5 kW	1	unit	1,360	1,700
M1 016	Mist Separator	Mist Separator 50.0m^3/min		1	unit	160	200
M1 017	Carbon adsorption tower	Treatment capacity -50m^3/day		1	unit	11,200	14,000
M1 18)	Piping			1	lot		7,708
Total							117,818

2 Main Pump Station-5

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M2 001	Inlet Gate	Motor Operated Cast Iron Gate W1000mm x H1000mm	2.2 kW	3	units	2,800	8,400
M2 002	Corase Bar Screen	Bar Screen (SUS304) W1.0m x H3.2m x O.P. 100mm		3	units	280	840
M2 003	Fine Automatic Bar Screen	Disintergrator with Automatic Bar Screen W1.0m x H3.2m x O.P. 20mm	2.2 kW	2	units	14,400	28,800
M2 004	Fine Bar Screen	Bar Screen (SUS304) W1.0m x H3.2m x O.P. 20mm		1	units	640	640
M2 005	Screening Washer whis Conveyer		1.5 kW	1	units	2,800	2,800
M2 006	Grit Collector	Chamber Area = 2.5m x 8.6m	2.2 kW	2	units	14,400	28,800
M2 007	Grit Washer with Container		3.7 kW	1	unit	16,000	16,000
M2 008	Submersible Pump	φ400mm x 16.9m3/min x 15m (stand-by 2)	60 kW	5	units	6,000	30,000
M2 009	Mixer	Submersible Mixer	3.7 kW	2	units	1,200	2,400
M2 010	Pump Well connection Gate	Manual Operated W600mm x H600mm		1	unit	640	640
M2 011	Discharge Valve	Electrical Motor Operation φ400mm	1.5 kW	4	units	1,360	5,440
M2 012	Hoist Block for Pump	Geared Trolley Chain Block 2.0ton x 15m	0.4 kW	1	unit	320	320
M2 013	Hoist Block for Cartridge 1	Geared Trolley Chain Block 1.0ton x 10m	0.2 kW	1	unit	280	280
M2 014	Hoist Block for Cartridge 2	Geared Trolley Chain Block 1.0ton x 3.5m	0.2 kW	1	unit	280	280
M2 015	Pump Station Odor Control Fan	FRP tubo fan 80.0m^3/min	3.7 kW	1	unit	1,760	1,760
M2 016	Mist Separator	Mist Separator 80.0m^3/min		1	unit	240	240
M2 017	Carbon adsorption tower	Treatment capacity -80m^3/day		1	unit		18,000
M2 018	Piping						10,195
Total							155,835

3 Primary Sedeimentation Tank

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M3 001	Inlet Gate	Manual Operation Sluice Gate		16	units	960	15,360
M3 002	Sludge Collector	Chain flight type collector W4.0m x L16.0m	0.75 kw	16	units	8,800	140,800
M3 003	Primary sluddge pump	Non-clog type sludge pump ϕ 150mm x 1.2m^3/min x 12m	5.5 kw	6	units	3,040	18,240
M3 004	Primary sludge draw-offf valve	Electrical Motor Operation ϕ 200mm	0.4 kw	16	units	880	14,080
M3 005	Scum Skimmer	Electrical Motor Operation ϕ 150mm x 3.5m	0.2 kw	16	units	1,040	16,640
M3 006	Scum Separator		1.5 kw	4	units	9,600	38,400
M3 007	Floor drain pump	Submersible pump 65mm x 0.5m3min x 10m	0.75 kW	8	units	520	4,160
M3 008	Piping			1	lot		17,338
Total							265,018

4 Reactor Tank

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M4 001	Inlet Gate	Manual Operation Movable Weir Gate		16	units	960	15,360
M4 002	Mixer	Submersible Mixer W4.0m x H16.0m	5.0 kw	16	units	2,400	38,400
M4 003	Aeration Diffuser	Ultra-Fine Bubble Diffusion system		8	units	20,000	160,000
M4 004	Antifoaming Spray	Spray nozzle		320	units	16	5,120
M4 005	Blower	Roots type displacement blower ϕ 300mm x 115m^3/min x 6.5 mAp	180.0 kw	8	units	11,200	89,600
M4 006	Flow control valve	Electrical Motor Operation butterfly valve	0.2 kw	8	units	1,040	8,320
M4 007	Floor drain pump	Submersible drain pump 65mm x 0.5 m3/min x 10m	0.75 kW	4	units	520	2,080
M4 008	Piping			1	lot		22,322
Total							341,202

5 Final Sedeimentation Tank

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M5 001	Inlet Gate	Manual operation sluice gate		16	units	960	15,360
M5 002	Sludge Collector	Chain flight type collector W4.0m x L43.0m	3.7 kW	16	units	24,000	384,000
M5 003	Excess Sludge Pump	Non-clog type sludge pump ϕ 150mm x 1.5m^3/min x 15m	7.5 kw	6	units	3,200	19,200
M5 004	Excess Sludge Draw-off Valve	Electrical Motor Operation ϕ 200mm	0.4 kw	16	units	880	14,080
M5 005	Return Sludge Pump	Non-clog type sludge pump ϕ 200mm x 2.5m^3/min x 5m	5.5 kw	6	units	3,200	19,200
M5 006	Return Sludge Draw-off Valve	Electrical Motor Operation ϕ 200mm	0.2 kw	16	units	880	14,080
M5 007	Scum Skimmer	Electrical Motor Operation ϕ 150mm x 3.5m	0.2 kw	16	units	1,040	16,640
M5 008	Scum Separator		1.5 kw	4	units	9,600	38,400
M5 009	Floor drain pump	Submersible drain pump 65mm x 0.5m3/min x 10m	0.75 kW	8	units	520	4,160
M5 010	Piping			1	lot		36,758
Total							561,878

6 UV disinfection

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M6 001	Ultraviolet Radiation system	Automatic opearation 75,000m$^{3/}$d	41.8 kw	1	units	240,000	240,000
M6 002	Flowmeter	Submersible type magnetic flow meter		2	units	3,200	6,400
M6 003	Treated water supply pump	Submersible pump (stand by 1) 80mm x 1.0m^3/min x 20m	5.5 kW	3	units	240	720
M6 004	Piping			1	lot		17,298
Total							264,418

7 Sludge Thickener

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M7 001	Thickener	Center Driven Gravity Thickener Dia. 11.0 x H4.0m	0.75 kW	4	units	17,600	70,400
M7 002	Sludge Draw-off Pump	Non-clog type sludge pump ϕ 150mm x 1.5m^3/min x 15m	7.5 kw	6	units	3,200	19,200
M7 003	Distribution Gate	Manual operation movable weir gate W400mm		4	units	960	3,840
M7 004	Floor drain pump	Submersible drain pump 65mm x 0.5 m3/min x 10m		4	units	520	2,080
M7 005	Piping						6,686
Total							102,206

8 Dewatering Facility

Unit: JPY (x 1,000)

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M8 001	Sludge Retaning Tank Mixer	W 4.0m x L 4.0m x H 3.0m	5.5 kw	4	units	2,800	11,200
M8 002	Sludge Density Meter			1	units	1,760	1,760
M8 003	Sludge Feed Pump	Progress Cavity Pump ϕ 150mm x 1.5m^3/min x 12m	11.0 kw	6	units	1,600	9,600
M8 004	Feed Sludge Meter	Magnetic flow meter		6	units	640	3,840
M8 005	Dehydrator	Screw press Dia. 1,000mm	8.1 kw	6	units	116,000	696,000
M8 006	Cake Coveyor	Trough blet conveyor W 0.6m x L 20m	3.7 kw	3	units	8,000	24,000
M8 007	Cake Hopper	Steel construction square Hopper -10m^3	3.0 kw	2	units	8,800	17,600
M8 008	Polymer Feeder	160 liter capacity feed capacity 5.4 liter/min	0.4 kw	2	units	5,600	11,200
M8 009	Polymer Disolution Tank	Steel construction self-standing 50m^3 (dia.4m x H4.5m)	2.2 kw	2	units	10,800	21,600
M8 010	Polymer Tank Charge-Over Valve	Electrical Motor Operation	0.4 kw	2	units	800	1,600
M8 011	Polymer Solution Feed Pump	Progress Cavity Pump 59.5 l/min	0.75 kw	6	units	1,000	6,000
M8 012	Polymer Solution Feed Meter	Magnetic flow meter		6	units	560	3,360
M8 013	Treated Water Tank	FRP tank - 40m^3		1	units	2,000	2,000
M8 014	Treated Water Supply Pump	Centrifugal pump 400 liter/min	3.7 kw	2	units	600	1,200
M8 015	Air Compressor	Reciprocating Type	3.7 kw	2	units	680	1,360
M8 016	Sump Pump	Submersible pump	1.5 kw	2	units	360	720
M8 017	Trolly Chain Block	Manual operation, 3 ton		2	units	200	400
M8 018	Floor dain pump	Submersible drain pump 65mm x 0.5 m3/min x 10m	0.75 kW	4	units	520	2,080
M8 019	Piping						57,086
Total							872,606

9 Odor Control

Unit: JPY

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M9 001	Induction fan	200m^3/min x 150mmAq x 7.5kw	7.5 kw	1	units	2,400	2,400
M9 002	Adsorption Tower	Treatment capacity 200m^3/min		1	units	27,600	27,600
M9 003	Mist Separator	Treatment capacity 200m^3/min		1	units	240	240
M9 004	Duct, Dampers			1	units	1,600	1,600
Total							31,840

10 Outlet

Unit: JPY

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M10 001	Slide Gate	1,200mm x 1,200mm		1	units	4,000	4,000
Total							4,000

11 Management and Maintenance Equipment

Unit: JPY

Equipment		Specifications		Q'ty	Unit	Unit Cost k\	Amount k\
M11 001	High-Velocity Jetting Machine			2	units	25,000	50,000
M11 002	Vacuum Truck	For Pipe Creaning		2	units	25,000	50,000
M11 003	Tanker Truck			2	units	10,000	20,000
M11 004	Car with Television Inspection			1	units	40,000	40,000
M11 005	Vehicles	(including 4-seats ×1, 7-seats×2, Special Purpose Vehicle ×10, 15-seats×1)		14	units	3,000	42,000
M11 006	Backhoe	0.3m3		2	units	10,000	20,000
M11 007	Dump Truck	4t		2	units	15,000	30,000
M11 008	Multipurpose Hydraulic Shovel	1.8m3		2	units	30,000	60,000
M11 009	Crane Track	4t		1	units	10,000	10,000
M11 010	Sludge Transfer Truck	10t		3	units	20,000	60,000
M11 011	Vacuum Truck	For Septic Tank		10	units	25,000	250,000
	Sub Total (1)	Vehicles					632,000
M11 012	Power Rodding Machines			2	units	500	1,000
M11 013	Power Bucket Machine			2	units	500	1,000
M11 014	Stop Plugs Assorted Diameters			6	units	100	600
M11 015	Mobile Generator	30kVA		5	units	5,000	25,000
	Sub Total (2)	Maintenance Equipments					27,600
Total							659,600

Appendix 8-B

Operation and Maintenance Cost Estimate

Operation & Maintenance Cost

Items		O&Mcost (VND/year)
〔A〕Direct O&M Cost		
1. Personnel Cost		
	Management Personnel	1,097,791,200
	Administration and Finance Personnel	6,627,682,800
	Technical Personnel	13,954,258,800
	Storm Water Drainage O&M Personnel	3,155,328,000
	Septic Tank Cleaning Personnel	4,338,576,000
	Sub total 1	**29,173,636,800**
2. Electricity Cost		
	Pumping Station-1	753,709,670
	STP2	15,319,539,830
	Manhole Type Pump Station	1,529,167,500
	Sub total 2	**17,602,417,000**
3. Sludge Disposal and Chemical Cost		
	Sludge Disposal	2,452,800,000
	Polymer cost	117,920,550,000
	Activated carbon	4,600,000,000
	UV Lamp Replacement	275,000,000
	Sub total 3	**125,248,350,000**
4. Repairs & Maintenance Cost		
	Site Work for STP2 Repair	28,178,000
	Sewerage Facilities Repair	18,547,323,299
	Drainage Facilities Repair	1,458,990,110
	Canal Improvement Repair	392,934,360
	Maintenance Machines Repair (for Sewerage Facilities)	1,805,299,729
	Maintenance Machines Repair (Drainage Facilities)	1,307,286,011
	Maintenance Machines Repair (for Septic Tank)	1,899,755,760
	Sewer Cleaning Work (for Sewerage)	2,419,612,819
	Sewer Cleaning Work (for Drainage)	1,752,133,421
	Septage Collecting Work	1,648,121,000
	Sludge Disposal Work	369,672,000
	Standby Generator Maintenance Work	35,321,400
	Sub total 4	**31,664,627,908**
5. Establishment Cost		
	Sub total 5	**120,000,000**
Sub Total A		**203,809,031,708**
〔B〕 Indirect O&M Cost (15% of Direct O&M Cost)		
Sub Total B		**30,571,354,756**
〔C〕 Depreciation Cost		
Site Work for STP2		563,560,000
Sewerage Facilities		
	Construction work	60,557,938,176
	Materials & Equipment	68,975,228,400
Drainage Facilities		29,179,802,192
Canal Improvement		7,858,687,200
Maintenance Equipment for Sewerage Facilities		6,017,665,764
Maintenance Equipment for Drainage Facilities		4,357,620,036
Maintenance Equipment for Septic Tank		6,332,519,200
Sub Total C		**183,843,020,968**
Total		**418,223,407,432**

1) Parsonnel Cost

		Numbers Total	Unit Price (VND/Staff	Annual Total (VND)
Management	Director	1	17,355,300	208,263,600
	Management support	1	14,068,500	168,822,000
	Internal Audit	2	14,317,500	343,620,000
	Vice Director	2	15,711,900	377,085,600
	Sub Total	6		1,097,791,200
Admini & Finance	Maneger	6	15,313,500	1,102,572,000
	Engineer/Assistant	41	11,229,900	5,525,110,800
	Sub Total	47		6,627,682,800
Technical	Maneger	6	15,313,500	1,102,572,000
	Inspector for Sewer	4	11,229,900	539,035,200
	Engineer/Operator	91	10,956,000	11,963,952,000
	Assitant	3	9,686,100	348,699,600
	Sub Total	104		13,954,258,800
For Drainage	Engineer/Operator	24	10,956,000	3,155,328,000
For Septage	Engineer/Operator	33	10,956,000	4,338,576,000
Total		214		29,173,636,800

2) Electricity Cost

PS-1	Daily Electricity use (kWh)	Annual Electricity use (kWh)	Annual Electrcity cost (VND.)
Pump Facilities	1,109	404,785	753,709,670

STP	Daily Electricity use (kWh)	Annual Electricity use (kWh)	Annual Electrcity cost (VND.)
PS-5	2,893	1,055,945	1,966,169,590
Primiary Sedimentation Tank	334	121,910	226,996,420
Reactor Tank	15,366	5,608,590	10,443,194,580
Final Sedimentation Tank	1,728	630,720	1,174,400,640
UV Disinfection	963	351,495	654,483,690
Sludge Thickener	107	39,055	72,720,410
Dewatering Facilities	1,006	367,190	683,707,780
Odor Control Facilities	144	52,560	97,866,720
Total			15,319,539,830

Manhole Type Pump Station	Effective power (kW)	Number of units	Daily run time (hour/unit)	Daily Electricity use (kWh)	Annual Electricity use (kWh)	Annual Electrcity cost (VND.)
Pump Facilities	7.5	2	12	90	32850	61,166,700
Total	25	Manholes				1,529,167,500

1,862 VND/kWh = Unit rate of electricity

Total Electricity Cost = 2,380,743,890 (VND/ year)

3) Sludge Disposal and Chemical Cost

3-1) Sludge Disposal

	Sludge disposal t/day	Cost/t (VND)	Annual cost (VND)
Disposal cost	42	160,000	2,452,800,000

3-2) Polymer

	Sludge production kg/day	Polymer usage rate	Cost/Kg (VND)	Annual cost (VND)
Polymer cost	445,000	0.01	72600	117,920,550,000

3-3) Activated Corbon

For odor control		
Required Ganular activated carbon per year =	4,000	Kg
Unit cost (VND)	1150000	
Annual Cost(VND)	4,600,000,000	

3-4) UV Lamp Replacement 275,000,000 VND/year

Total Chemical Cost = 125,248,350,000 (VND/year)

4) REPAIRS & MAINTENANCE COST

Site Work for STP2

	Capital Cost (1,000VND)	Annual repair and maintenance cost % of Capital Cost	(VND/year)
Construction Work	28,178,000	0.10%	28,178,000
Total	28,178,000		28,178,000

Sewerage Facilities

	Capital Cost (1,000VND)	Annual repair and maintenance cost % of Capital Cost	(VND/year)
Construction Work	3,027,896,909	0.10%	3,027,896,909
Main Equipment	1,034,628,426	1.50%	15,519,426,390
Total	4,062,525,335		18,547,323,299

Drainage Facilities

	Capital Cost (1,000VND)	Annual repair and maintenance cost % of Capital Cost	(VND/year)
Construction Work	1,458,990,110	0.10%	1,458,990,110
Main Equipment			0
Total	1,458,990,110		1,458,990,110

Canal Improvement

	Capital Cost (1,000VND)	Annual repair and maintenance cost % of Capital Cost	(VND/year)
	392,934,360	0.10%	392,934,360
Total	392,934,360		392,934,360

Maintenance Equipment for Sewerge and Drainage Facilities

	Capital Cost (1,000VND)	Annual repair and maintenance cost % of Capital Cost	(VND/year)
Equipment and Material	103,752,858	3.00%	3,112,585,740
			0
Total	103,752,858		3,112,585,740

Maintenance Equipment for Septic tank

	Capital Cost (1,000VND)	Annual repair and maintenance cost % of Capital Cost	(VND/year)
Equipment and Material	63,325,192	3.00%	1,899,755,760
			0
Total	63,325,192		1,899,755,760

Sewer Cleaning Diesel fuel Unit Price = 21,100 VND/liter

	No of days/ year	Fuel Consumption (liter/hours)	Working Time (hours/day)	Unit cost/ (VND/liter)	Unit cost/ day*	No of sets	Total cost (VND/year)
Jetting Machine	225	5.9	6	21,100	896,328	2	403,347,600
Vacuum Truck	225	7.6	6	21,100	1,154,592	2	519,566,400
Tanker Truck	225	5.3	6	21,100	805,176	2	362,329,200
Rod Machine	225	3.4	6	21,100	516,528	2	232,437,600
Bucket Machine	225	1.4	6	21,100	212,688	2	95,709,600
TV Inspection	225	5.0	6	21,800	784,800	1	176,580,000
Van	150	2.6	6	21,800	408,096	14	857,001,600
Backhoe	150	4.0	6	21,100	607,680	2	182,304,000
Dump Truck	150	12.0	6	21,100	1,823,040	2	546,912,000
Crane Truck	150	4.4	6	21,100	668,448	1	100,267,200
Others (20%)							695,291,040
Total							4,171,746,240

*Unit cost is including lubricant cost (20%)

Septage collecting

Sludge volume (m3/day)	Transportable sludge volume per track (m3)	Number of trips per day	Travel distance (km/day)	Fuel consumption (km/liter)	Fuel cost (VND/liter)	Fuel cost (VND/year)	Lubricant (20% of fuel) (VND/year)
107	4	27	535	3	21,100	1,373,434,167	274,686,833
	Total cost (VND/year) =	1,648,121,000					

Sludge Disposal

Sludge volume (m3/day)	Transportable sludge volume per track (m3)	Number of trips per day	Travel distance (km/day)	Fuel consumption (km/liter)	Fuel cost (VND/liter)	Fuel cost (VND/year)	Lubricant (20% of fuel) (VND/year)
60	10	6	120	3	21,100	308,060,000	61,612,000
	Total cost (VND/year) =	369,672,000					

Standby Generator (for maintenance operation)

	Capacity (kVA)	Unit Consumption (liter/kVA/hour)	Working Time (hours/month)	Unit cost/ (VND/liter)	Unit cost/ day*	No of sets	Total cost (VND/year)
Pump Station-1	80	0.25	6	21,100	37,980	1	3,038,400
Pump Station-2	200	0.25	6	21,100	37,980	1	7,596,000
STP2	500	0.25	6	21,100	37,980	1	18,990,000
Mobile Generator	30	0.25	6	21,100	37,980	5	5,697,000
	Total cost (VND/year) =	35,321,400					

5) ESTABLISHMENT COSTS

Establishment cost is estimated at		10,000,000	(VND/month)
	or	120,000,000	(VND/year)

Appendix 8-C

Annual Disbursement for Financial and Economic Analysis

Appendix 8-C Annual Disbursement for Financial and Economic Analysis

1. Capital Cost

(1) Total Base Cost

The capital cost for financial and economic analysis is converted from the base cost for the project cost estimated in Chapter 8 based on the following assumptions as shown in Table A8-C-1.

Assumptions applied for financial analysis are:

- All prices are expressed in 2011 constant price.
- Price escalation and interest during construction are excluded from calculation.

Assumptions applied for economic analysis are:

- All prices are expressed in 2011 constant price.
- Price escalation, taxes, interest during construction, and land acquisition costs are excluded from calculation.
- Standard conversion factor of 0.9 is applied to acquire economic values of local currency costs.

Table A8-C-1 Base Capital Cost for Financial and Economic Analysis

A. Construction Cost million VND

Description	for Project Cost			Total Cost for Financial Analysis	Total Cost for Economic Analysis
	Foreign	Local	Total		
PACKAGE Groups: Site Work for STP2					
Primary Site Work for STP2	0	28,178	28,178	28,178	25,360
Total	0	28,178	28,178	28,178	25,360
PACKAGE Groups : Sewerage and Drainage Facilities					
Construction Work					
Sewerage Facilities	665,883	1,282,255	1,948,138	1,948,138	1,819,913
Drainage Facilities	399,606	1,059,384	1,458,990	1,458,990	1,353,052
2.1 Bien Hung Ditch Diversion	285,584	27,839	313,423	313,423	310,639
Pumping Station-1	6,903	27,549	34,452	34,452	31,697
Pumping Station-5	10,373	39,863	50,236	50,236	46,250
STP2	136,265	545,382	681,648	681,648	627,109
Sub-Total	1,504,614	2,982,273	4,486,887	4,486,887	4,188,660
Equipment and Material					
Sewerage Facilities	61,294	0	61,294	61,294	61,294
2.1 Bien Hung Ditch Diversion	2,761	0	2,761	2,761	2,761
Pumping Station-1	42,850	0	42,850	42,850	42,850
Pumping Station-5	60,182	0	60,182	60,182	60,182
STP2	867,542	0	867,542	867,542	867,542
Sub-Total	1,034,628	0	1,034,628	1,034,628	1,034,628
Total	2,539,243	2,982,273	5,521,515	5,521,515	5,223,288
PACKAGE Groups: Canal Improvement					
Canal Improvement	0	392,934	392,934	392,934	353,641
Total	0	392,934	392,934	392,934	353,641
PACKAGE Groups: Maintenance Equipment					
Maintenance Equipment for Sewerage	0	60,177	60,177	60,177	54,159
Maintenance Equipment for Drainage	0	43,576	43,576	43,576	39,219
Maintenance Equipment for Septic	0	63,325	63,325	63,325	56,993
Total	0	167,078	167,078	167,078	150,370
Total Construction Cost	2,539,243	3,570,463	6,109,706	6,109,706	5,752,660

B. Consulting Service Cost million VND

Description	for Project Cost			Total Cost for Financial Analysis	Total Cost for Economic Analysis
	Foreign	Local	Total		
D/D, Tender Assistance and SV	287,844	228,258	516,102	516,102	493,276
(including Survey Works)		27,232			
Capacity Build	39,523	20,029	59,552	59,552	57,549
IEC Campaign	19,014	12,019	31,033	31,033	29,831
Total Consulting Service	346,381	260,306	606,687	606,687	580,656

(2) Base Capital Cost for Financial Analysis

The base capital cost is distributed to three project components (sewerage, septage collection and drainage) for financial analysis as shown in Table A8-C-2. The consulting services cost is shared pro rata in accordance with construction cost of sewerage and drainage components.

Table A8-C-2 Base Capital Cost by Project Components for Financial Analysis

million VND

Description	Total Cost for Financial Analysis	Cost of Each Component		
		Sewerage	Septage Collection	Drainage
PACKAGE Groups: Site Work for STP2				
Primary Site Work for STP2	28,178	28,178		
Total	28,178	28,178	0	0
PACKAGE Groups : Sewerage and Drainage Facilities				
Construction Work				
Sewerage Facilities	1,948,138	1,948,138		
Drainage Facilities	1,458,990			1,458,990
2.1 Bien Hung Ditch Diversion	313,423	313,423		
Pumping Station-1	34,452	34,452		
Pumping Station-5	50,236	50,236		
STP2	681,648	681,648		
Sub-Total	4,486,887	3,027,897		1,458,990
Equipment and Material				
Sewerage Facilities	61,294	61,294		
2.1 Bien Hung Ditch Diversion	2,761	2,761		
Pumping Station-1	42,850	42,850		
Pumping Station-5	60,182	60,182		
STP2	867,542	867,542		
Sub-Total	1,034,628	1,034,628	0	0
Total	5,521,515	4,062,525	0	1,458,990
PACKAGE Groups: Canal Improvement				
Canal Improvement	392,934	0	0	392,934
Total	392,934	0	0	392,934
PACKAGE Groups: Maintenance Equipment				
Maintenance Equipment for Sewerage	60,177	60,177		
Maintenance Equipment for Drainage	43,576			43,576
Maintenance Equipment for Septic	63,325		63,325	
Total	167,078	60,177	63,325	43,576
Total Construction Cost	6,109,706	4,150,880	63,325	1,895,501

B. Consulting Service Cost million VND

Description	Total Cost for Financial Analysis	Cost of Each Component		
		Sewerage	Septage Collection	Drainage
Total Consulting Service	606,687	415,590	0	191,097

(3) Base Capital Cost for Economic Analysis

The base construction cost is distributed to two project components (sewerage and drainage) for economic analysis as shown in the Table A8-C-3.

Table A8-C-3 Base Construction Cost by Project Components for Economic Analysis

million VND

Description	Total Cost for Economic Analysis	Cost of Each Component	
		Sewerage	Drainage
PACKAGE Groups: Site Work for STP2			
Primary Site Work for STP2	25,360	25,360	
Total	25,360	25,360	0
PACKAGE Groups : Sewerage and Drainage Facilities			
Construction Work			
Sewerage Facilities	1,819,913	1,819,913	
Drainage Facilities	1,353,052		1,353,052
2.1 Bien Hung Ditch Diversion	310,639	310,639	
Pumping Station-1	31,697	31,697	
Pumping Station-5	46,250	46,250	
STP2	627,109	627,109	
Sub-Total	4,188,660	2,835,608	1,353,052
Equipment and Material			
Sewerage Facilities	61,294	61,294	
2.1 Bien Hung Ditch Diversion	2,761	2,761	
Pumping Station-1	42,850	42,850	
Pumping Station-5	60,182	60,182	
STP2	867,542	867,542	
Sub-Total	1,034,628	1,034,628	0
Total	5,223,288	3,870,236	1,353,052
PACKAGE Groups: Canal Improvement			
Canal Improvement	353,641	0	353,641
Total	353,641	0	353,641
PACKAGE Groups: Maintenance Equipment			
Maintenance Equipment for Sewerage	54,159	54,159	
Maintenance Equipment for Drainage	39,219		39,219
Maintenance Equipment for Septic	56,993	56,993	
Total	150,370	111,152	39,219
Total Construction Cost	5,752,660	4,006,748	1,745,911

The annual distributions of the base construction cost of sewerage and drainage facilities are shown in Table A8-C-4 and Table A8-C-5.

Table A8-C-4 Annual Distribution of Sewerage Facilities for Economic Analysis (million VND)

		2012		2013		2014		2015		2016		2017		2018		2019	
	Total Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost
PACKAGE Groups: Site Work for STP2	25,360	25.00%	6,340	75.00%	19,020	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
PACKAGE Groups : Sewerage and Drainage Facilities																	
Construction Work	2,835,608	0.00%	0	0.00%	0	3.70%	105,023	22.22%	630,135	22.22%	630,135	22.22%	630,135	22.22%	630,135	7.41%	210,045
Equipment and Material	1,034,628	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	30.43%	314,887	52.17%	539,806	17.39%	179,935
PACKAGE Groups: Canal Improvement	0	0.00%	0	7.41%	0	22.22%	0	22.22%	0	22.22%	0	22.22%	0	3.70%	0	0.00%	0
PACKAGE Groups: Maintenance Equipment	111,152	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	100.00%	111,152	0.00%	0
Total Construction Cost	4,006,748		6,340		19,020		105,023		630,135		630,135		945,022		1,281,093		389,980

Table A8-C-5 Annual Distribution of Drainage Facilities for Economic Analysis (million VND)

		2012		2013		2014		2015		2016		2017		2018		2019	
	Total Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost
PACKAGE Groups: Site Work for STP2	0	25.00%	0	25.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
PACKAGE Groups : Sewerage and Drainage Facilities																	
Construction Work	1,353,052	0.00%	0	0.00%	0	3.70%	50,113	22.22%	300,678	22.22%	300,678	22.22%	300,678	22.22%	300,678	7.41%	100,226
Equipment and Material	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	30.43%	0	52.17%	0	17.39%	0
PACKAGE Groups: Canal Improvement	353,641	0.00%	0	7.41%	26,196	22.22%	78,587	22.22%	78,587	22.22%	78,587	22.22%	78,587	3.70%	13,098	0.00%	0
PACKAGE Groups: Maintenance Equipment	39,219	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	100.00%	39,219	0.00%	0
Total Construction Cost	1,745,911		0		26,196		128,700		379,265		379,265		379,265		352,995		100,226

Annual disbursement for revolving fund is projected as per Table A8-C-6. The disbursements for revolving fund are allocated to the sewerage component in financial and economic analysis.

Table A8-C-6 Disbursements for Revolving Fund

	Unit	Total	2016	2017	2018	2019	2020
Seed Fund Requirement*	million VND	446,000	89,200	89,200	89,200	89,200	89,200
Price Escalation Rate (Based on 2011)	-		1.647	1.820	2.012	2.223	2.456
2011 Price for Financial Analysis	million VND	223,934	54,144	48,999	44,343	40,130	36,317
2011 Price for Economic Analysis	million VND	201,540	48,730	44,100	39,909	36,117	32,685

* Reference : Case 3 of Table 7.8.6 Revolving Loan Financial Projections in Chapter 7

Annual disbursement of the consulting services base cost for economic analysis is projected as per Table A8-C-7.

Table A8-C-7 Base Consulting Services Cost for Economic Analysis

		Total	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Consulting Services		606,687	0	99,692	118,586	37,520	85,358	67,936	68,255	67,821	49,738	11,782
	Local	260,306	0	52,330	43,719	15,662	35,496	31,582	32,544	30,894	15,403	2,676
	Foreign	346,381	0	47,362	74,867	21,858	49,862	36,353	35,711	36,927	34,335	9,106
Cost for Economic Analysis		580,656	0	94,459	114,214	35,954	81,808	64,777	65,001	64,731	48,198	11,514

Table A8-C-8 shows the annual disbursements of the total capital cost of each component. The consulting services cost is shared pro rata in accordance with the construction cost of each component. Physical contingency, disbursements for the revolving fund, and administration cost are added to acquire total capital cost used for economic analysis.

Table A8-C-8 Annual Distribution of Capital Expenditure for Economic Analysis (million VND)

		2012		2013		2014		2015		2016		2017		2018		2019		2020	
	Total Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost
I. ELIGIBLE PORTION	6,851,522		105,839		167,401		283,160		1,145,769		1,176,616		1,502,852		1,823,669		601,441		44,775
Sewerage Facilities	4,828,379		105,839		70,418		127,237		715,266		753,956		1,085,678		1,438,676		486,535		44,775
Drainage Facilities	2,023,143		0		96,983		155,923		430,503		422,661		417,174		384,993		114,906		0
A. Construction Cost	6,241,833		6,657		47,477		245,409		1,059,870		1,108,600		1,434,601		1,755,701		550,834		32,685
Sewerage Facilities	**4,408,626**	**100.00%**	**6,657**	**42.07%**	**19,971**	**44.93%**	**110,274**	**62.43%**	**661,642**	**64.08%**	**710,372**	**72.24%**	**1,036,373**	**78.89%**	**1,385,057**	**80.89%**	**445,596**	**100.00%**	**32,685**
Sewerage Facilities	4,207,086		6,657		19,971		110,274		661,642		661,642		992,273		1,345,148		409,479		0
Procurement / Construction Base Cost	4,006,748		6,340		19,020		105,023		630,135		630,135		945,022		1,281,093		389,980		0
Physical Contingency	200,337		317		951		5,251		31,507		31,507		47,251		64,055		19,499		0
Disbursements for Revolving Fund	201,540										48,730		44,100		39,909		36,117		32,685
Drainage Facilities	**1,833,207**	**0.00%**	**0**	**57.93%**	**27,505**	**55.07%**	**135,135**	**37.57%**	**398,228**	**35.92%**	**398,228**	**27.76%**	**398,228**	**21.11%**	**370,644**	**19.11%**	**105,237**	**0.00%**	**0**
Procurement / Construction Base Cost	1,745,911		0		26,196		128,700		379,265		379,265		379,265		352,995		100,226		0
Physical Contingency	87,296		0		1,310		6,435		18,963		18,963		18,963		17,650		5,011		0
B. Consulting Services																			
Base Cost	580,656		94,459		114,214		35,954		81,808		64,777		65,001		64,731		48,198		11,514
Physical Contingency	29,033		4,723		5,711		1,798		4,090		3,239		3,250		3,237		2,410		576
Sewerage Facilities	419,753		99,182		50,447		16,963		53,624		43,584		49,305		53,619		40,939		12,090
Base Cost	**399,765**	**100.00%**	**94,459**	**42.07%**	**48,044**	**44.93%**	**16,156**	**62.43%**	**51,070**	**64.08%**	**41,508**	**72.24%**	**46,957**	**78.89%**	**51,066**	**80.89%**	**38,990**	**100.00%**	**11,514**
Physical Contingency	19,988		4,723		2,402		808		2,554		2,075		2,348		2,553		1,949		576
Drainage Facilities	189,936		0		69,478		20,788		32,275		24,433		18,946		14,349		9,669		0
Base Cost	**180,892**	**0.00%**	**0**	**57.93%**	**66,169**	**55.07%**	**19,798**	**37.57%**	**30,738**	**35.92%**	**23,269**	**27.76%**	**18,043**	**21.11%**	**13,665**	**19.11%**	**9,208**	**0.00%**	**0**
Physical Contingency	9,045		0		3,308		990		1,537		1,163		902		683		460		0
II. NON-ELIGIBLE PORTION	205,546		3,175		5,022		8,495		34,373		35,298		45,086		54,710		18,043		1,343
Adiministration Cost (3% of eligible)	205,546		3,175		5,022		8,495		34,373		35,298		45,086		54,710		18,043		1,343
Sewerage Facilities	144,851		3,175		2,113		3,817		21,458		22,619		32,570		43,160		14,596		1,343
Drainage Facilities	60,694		0		2,909		4,678		12,915		12,680		12,515		11,550		3,447		0
Capital Expenditure	7,057,067		109,015		172,423		291,655		1,180,142		1,211,915		1,547,937		1,878,379		619,484		46,118
Sewerage Facilities	**4,973,230**		**109,015**		**72,530**		**131,054**		**736,724**		**776,574**		**1,118,248**		**1,481,836**		**501,131**		**46,118**
Drainage Facilities	**2,083,837**		**0**		**99,893**		**160,600**		**443,418**		**435,341**		**429,689**		**396,543**		**118,353**		**0**

2. Operation and Maintenance Cost

(1) Operation and Maintenance Cost for Financial Analysis

The operation and maintenance (O&M) cost for financial analysis is converted from the cost estimation in Chapter 8 based on the following assumptions:

- All prices are expressed in 2011 constant price.
- The costs for electricity and chemicals are reduced to 90% because the actual influent quantity comes less than the full capacity (52,000$m^{3/}$day) of STP2.

Table A8-C-9 shows the O&M cost by the three project components (sewerage, septage collection and drainage).

Table A8-C-9 Operation & Maintenance Cost for Financial Analysis (million VND/year)

Items		Total	Sewerage Component	Collection Component	Drainage Component
〔A〕Direct O&M Cost					
1. Personnel Cost					
	Management Personnel	1,098	1,098		
	Administration and Finance Personnel	6,076	6,076		
	Technical Personnel	16,854	16,854		
	Storm Water Drainage O&M Personnel	3,287			3,287
	Septic Tank Cleaning Personnel	4,339		4,339	
	Sub total 1	31,653	24,028	4,339	3,287
2. Electricity Cost (Maximum 90%)					
	Pumping Station-1	678	678		
	STP2	13,788	13,788		
	Manhole Type Pump Station	1,376	1,376		
	Sub total 2	15,842	15,842	0	0
3. Sludge Disposal and Chemical Cost					
	Sludge Disposal	2,208	2,208		
	Polymer cost	106,128	106,128		
	Activated carbon	4,140	4,140		
	UV Lamp Replacement	248	248		
	Sub total 3	112,724	112,724	0	0
4. Repairs & Maintenance Cost					
	Site Work for STP2 Repair	28	28		
	Sewerage Facilities Repair	18,547	18,547		
	Drainage Facilities Repair	1,459			1,459
	Canal Improvement Repair	393			393
	Maintenance Machines Repair (for Sewerage Facilities)	1,805	1,805		
	Maintenance Machines Repair (Drainage Facilities)	1,307			1,307
	Maintenance Machines Repair (for Septic Tank)	1,900		1,900	
	Sewer Cleaning Work (for Sewerage)	2,420	2,420		
	Sewer Cleaning Work (for Drainage)	1,752			1,752
	Septage Collecting Work	1,648		1,648	
	Sludge Disposal Work	370	370		
	Standby Generator Maintenance Work	35	35		
	Sub total 4	31,665	23,205	3,548	4,911
5. Establishment Cost					
	Sub total 5	120	120		
Sub Total A		192,004	175,919	7,886	8,198
〔B〕 Indirect O&M Cost (15% of Direct O&M Cost)					
Sub Total B		28,801	26,388	1,183	1,230
〔C〕 Depreciation Cost					
Site Work for STP2		564	564		
Sewerage Facilities					
	Construction work	60,558	60,558		
	Materials & Equipment	68,975	68,975		
Drainage Facilities		29,180			29,180
Canal Improvement		7,859			7,859
Maintenance Equipment for Sewerage Facilities		6,018	6,018		
Maintenance Equipment for Drainage Facilities		4,358			4,358
Maintenance Equipment for Septic Tank		6,333		6,333	
Sub Total C		183,843	136,114	6,333	41,396
Total		404,647	338,421	15,402	50,824

(2) Operation and Maintenance Cost for Economic Analysis

Table A8-C-10 shows the O&M cost by the two project components (sewerage and drainage) converted from the financial cost based on the following assumptions:

- All prices are expressed in 2011 constant price.
- Depreciation costs are excluded from the calculation.
- Standard conversion factor of 0.9 is applied to acquire economic values of local currency costs.
- The costs for electricity and chemical are reduced to 90% because the influent quantity comes up shot to capacity (52,000m^3/day) of STP2.
- Septage collection is included in the sewerage component.

Table A8-C-10 Operation & Maintenance Cost for Economic Analysis (million VND/year)

Items		Total	Sewerage Component	Drainage Component
〔A〕Direct O&M Cost				
1. Personnel Cost				
	Management Personnel	988	988	
	Administration and Finance Personnel	5,469	5,469	
	Technical Personnel	15,168	15,168	
	Storm Water Drainage O&M Personnel	2,958		2,958
	Septic Tank Cleaning Personnel	3,905	3,905	
	Sub total 1	28,488	25,530	2,958
2. Electricity Cost (Maximum 90%)				
	Pumping Station-1	611	611	
	STP2	12,409	12,409	
	Manhole Type Pump Station	1,239	1,239	
	Sub total 2	14,258	14,258	0
3. Sludge Disposal and Chemical Cost				
	Sludge Disposal	1,987	1,987	
	Polymer cost	95,516	95,516	
	Activated carbon	3,726	3,726	
	UV Lamp Replacement	223	223	
	Sub total 3	101,451	101,451	0
4. Repairs & Maintenance Cost				
	Site Work for STP2 Repair*	25	25	
	Sewerage Facilities Repair*	18,355	18,355	
	Drainage Facilities Repair*	1,353		1,353
	Canal Improvement Repair*	354		354
	Maintenance Machines Repair (for Sewerage Facilities)	1,625	1,625	
	Maintenance Machines Repair (Drainage Facilities)	1,177		1,177
	Maintenance Machines Repair (for Septic Tank)	1,710	1,710	
	Sewer Cleaning Work (for Sewerage)	2,178	2,178	
	Sewer Cleaning Work (for Drainage)	1,577		1,577
	Septage Collecting Work	1,483	1,483	
	Sludge Disposal Work	333	333	
	Standby Generator Maintenance Work	32	32	
	Sub total 4	30,201	25,740	4,460
5. Establishment Cost				
	Sub total 5	108	108	
Sub Total A		174,506	167,087	7,418
〔B〕 Indirect O&M Cost (15% of Direct O&M Cost)				
Sub Total B		26,176	25,063	1,113
Total		200,682	192,151	8,531

*Reference : Table A8-C-11 Repair Cost for Economical Analysis

Table A8-C-11 shows the estimation of repair cost in economic values.

Table A8-C-11 Repair Cost for Economic Analysis

Site Work for STP2

	Capital Cost (1,000VND) - Economic Value			Annual repair and maintenance cost (VND/year) - Economic Value			
	FC	LC	Total	% of Capital Cost	FC	LC	Total
Construction Work	0	25,360,200	25,360,200	0.10%	0	25,360,200	25,360,200
Total			25,360,200		0		25,360,200

Sewerage Facilities

	Capital Cost (1,000VND) - Economic Value			Annual repair and maintenance cost (VND/year) - Economic Value			
	FC	LC	Total	% of Capital Cost	FC	LC	Total
Construction Work	1,105,008,514	1,730,599,555	2,835,608,069	0.10%	1,105,008,514	1,730,599,555	2,835,608,069
Main Equipment	1,034,628,426		1,034,628,426	1.50%	15,519,426,390	0	15,519,426,390
Total			3,870,236,495				18,355,034,459

Drainage Facilities

	Capital Cost (1,000VND) - Economic Value			Annual repair and maintenance cost (VND/year) - Economic Value			
	FC	LC	Total	% of Capital Cost	FC	LC	Total
Construction Work	399,605,955	953,445,739	1,353,051,694	0.10%	399,605,955	953,445,739	1,353,051,694
Main Equipment							0
Total			1,353,051,694				1,353,051,694

Canal Improvement

	Capital Cost (1,000VND) - Economic Value			Annual repair and maintenance cost (VND/year) - Economic Value			
	FC	LC	Total	% of Capital Cost	FC	LC	Total
Construction Work		353,640,924	353,640,924	0.10%	0	353,640,924	353,640,924
Total			353,640,924				353,640,924

The annual O&M cost of each component for economic analysis is calculated as per Table A8-C-12 and Table A8-C-13 based on the expenditure rate projection over the project lifetime.

Table A8-C-12 Annual O&M Cost of Sewerage Facilities for Economic Analysis (million VND)

		2014		2015		2016		2017		2018		2019		2020		2021 and onward	
	Total Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost
A. Direct O&M Cost	167,087		5,169		5,169		7,233		8,405		15,821		89,934		154,231		167,087
1. Personnel	25,530		5,115		5,115		7,179		8,351		15,713		25,530		25,530		25,530
Management Personnel	988	100%	988	100%	988	100%	988	100%	988	100%	988	100%	988	100%	988	100%	988
Administration and Finance Personnel	5,469	20%	1,094	20%	1,094	30%	1,641	30%	1,641	60%	3,281	100%	5,469	100%	5,469	100%	5,469
Technical Personnel	15,168	20%	3,034	20%	3,034	30%	4,551	30%	4,551	60%	9,101	100%	15,168	100%	15,168	100%	15,168
Storm Water Drainage O&M Personnel	0	0%	0	0%	0	0%	0	30%	0	60%	0	100%	0	100%	0	100%	0
Septic Tank Cleaning Personnel	3,905	0%	0	0%	0	0%	0	30%	1,171	60%	2,343	100%	3,905	100%	3,905	100%	3,905
2. Electricity	14,258	0%	0	0%	0	0%	0	0%	0	0%	0	44%	6,337	89%	12,674	100%	14,258
3. Chemical	101,451	0%	0	0%	0	0%	0	0%	0	0%	0	44%	45,089	89%	90,179	100%	101,451
4. Repairs and Maintenance	25,740	0%	0	0%	0	0%	0	0%	0	0%	0	50%	12,870	100%	25,740	100%	25,740
5. Estabishment Cost	108	50%	54	50%	54	50%	54	50%	54	100%	108	100%	108	100%	108	100%	108
B. Indirect O&M Cost	25,063		775		775		1,085		1,261		2,373		13,490		23,135		25,063
Total Construction Cost	192,151		5,945		5,945		8,318		9,665		18,194		103,425		177,366		192,151

Table A8-C-13 Annual O&M Cost of Drainage Facilities for Economic Analysis (million VND)

		2014		2015		2016		2017		2018		2019		2020		2021 and onward	
	Total Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost
A. Direct O&M Cost	7,418		0		0		0		887		1,775		5,188		7,418		7,418
1. Personnel	2,958		0		0		0		887		1,775		2,958		2,958		2,958
Management Personnel	0	100%	0	100%	0	100%	0	100%	0	100%	0	100%	0	100%	0	100%	0
Administration and Finance Personnel	0	20%	0	20%	0	30%	0	30%	0	60%	0	100%	0	100%	0	100%	0
Technical Personnel	0	20%	0	20%	0	30%	0	30%	0	60%	0	100%	0	100%	0	100%	0
Storm Water Drainage O&M Personnel	2,958	0%	0	0%	0	0%	0	30%	887	60%	1,775	100%	2,958	100%	2,958	100%	2,958
2. Electricity	0	0%	0	0%	0	0%	0	0%	0	0%	0	44%	0	89%	0	100%	0
3. Chemical	0	0%	0	0%	0	0%	0	0%	0	0%	0	44%	0	89%	0	100%	0
4. Repairs and Maintenance	4,460	0%	0	0%	0	0%	0	0%	0	0%	0	50%	2,230	100%	4,460	100%	4,460
5. Estabishment Cost	0	50%	0	50%	0	50%	0	100%	0	100%	0	100%	0	100%	0	100%	0
B. Indirect O&M Cost	1,113		0		0		0		133		266		778		1,113		1,113
Total Construction Cost	8,531		0		0		0		1,021		2,041		5,966		8,531		8,531

Appendix 10-A

Decision for EIA

TỈNH ĐỒNG NAI

Số: 426 /QĐ-UBND

Độc lập - Tự do - Hạnh phúc

Biên Hòa, ngày 23 tháng 02 năm 2009

QUYẾT ĐỊNH

Về việc phê duyệt báo cáo đánh giá tác động môi trường Dự án "Đầu tư xây dựng hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa – giai đoạn 1" của Ban Quản lý Dự án thoát nước Đồng Nai thuộc Sở Xây dựng Đồng Nai.

CHỦ TỊCH ỦY BAN NHÂN DÂN TỈNH ĐỒNG NAI

Căn cứ Luật Tổ chức HĐND và UBND ngày 26 tháng 11 năm 2003;

Căn cứ Luật Bảo vệ môi trường ngày 29 tháng 11 năm 2005;

Căn cứ Nghị định số 80/2006/NĐ-CP ngày 09 tháng 8 năm 2006 của Chính phủ; Nghị định số 21/2008/NĐ-CP ngày 28/02/2008 của Chính phủ về sửa đổi, bổ sung một số điều của Nghị định số 80/2006/NĐ-CP ngày 09 tháng 8 năm 2006 của Chính phủ về việc quy định chi tiết và hướng dẫn thi hành một số điều của Luật Bảo vệ môi trường;

Căn cứ Nghị định số 59/2007/NĐ-CP ngày 09/4/2007 của Chính phủ về quản lý chất thải rắn;

Căn cứ Thông tư số 08/2006/TT-BTNMT ngày 08/9/2006 của Bộ Tài nguyên và Môi trường hướng dẫn về đánh giá tác động môi trường chiến lược, đánh giá tác động môi trường và cam kết bảo vệ môi trường và Thông tư số 12/2006/TT-BTNMT ngày 26/12/2006 của Bộ Tài nguyên và Môi trường về hướng dẫn điều kiện hành nghề và thủ tục lập hồ sơ, đăng ký, cấp phép hành nghề, mã số quản lý chất thải nguy hại;

Căn cứ Quyết định số 22/2006/QĐ-BTNMT ngày 18/12/2006 về việc bắt buộc áp dụng Tiêu chuẩn Việt Nam về môi trường và Quyết định số 23/2006/QĐ-BTNMT ngày 26/12/2006 về việc ban hành Danh mục chất thải nguy hại của Bộ Tài nguyên và Môi trường;

Căn cứ Quyết định số 65/2007/QĐ-UBND ngày 11/12/2007 của UBND tỉnh Đồng Nai về việc phân vùng môi trường tiếp nhận nước thải và khí thải công nghiệp trên địa bàn tỉnh Đồng Nai;

Theo đề nghị của Hội đồng thẩm định báo cáo đánh giá tác động môi trường Dự án "Đầu tư xây dựng hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa – giai đoạn 1" của Ban Quản lý Dự án thoát nước Đồng Nai thuộc Sở Xây dựng Đồng Nai, họp ngày 20/3/2008;

Xét nội dung báo cáo đánh giá tác động môi trường của Dự án "Đầu tư xây dựng hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa – giai đoạn 1", đã được chỉnh sửa bổ sung tại văn bản giải trình số 103/BQLTN-BH ngày 15 tháng 12 năm 2008 và số 04/BQLTN-BH ngày 13/01/2009 của Ban Quản lý Dự án thoát nước Đồng Nai thuộc Sở Xây dựng Đồng Nai;

Theo đề nghị của Giám đốc Sở Tài nguyên và Môi trường tại tờ trình số 132/TTr-TNMT ngày 16/ 02 /2009.

Số 2, Nguyễn Văn Trị, P. Thanh Bình, Tp. Biên Hòa
TEL: (061)3822501 - FAX: (061)3823854 - 824934

Điều 1. Phê duyệt nội dung Báo cáo đánh giá tác động môi trường Dự án "Đầu tư xây dựng hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa – giai đoạn 1" của Ban Quản lý Dự án thoát nước Đồng Nai thuộc Sở Xây dựng Đồng Nai (dưới đây gọi là Chủ dự án).

Điều 2. Chủ dự án có trách nhiệm thực hiện đúng những nội dung được nêu trong Báo cáo đánh giá tác động môi trường này và những yêu cầu bắt buộc sau đây:

1. Tuân thủ quy hoạch tổng thể của dự án và thành phố Biên Hòa đã được cấp thẩm quyền phê duyệt. Tuân thủ Quy chuẩn Xây dựng Việt Nam và các quy định nhà nước liên quan về tỷ lệ diện tích cây xanh, khoảng cách ly vệ sinh công trình của dự án.

2. Trong quá trình thi công xây dựng và hoạt động dự án phải tuân thủ thực hiện các biện pháp bảo vệ môi trường và đảm bảo xử lý các loại chất thải đạt các tiêu chuẩn, quy chuẩn Việt Nam về môi trường; Nghị định số 59/2007/NĐ-CP ngày 09/4/2007 của Chính phủ về quản lý chất thải rắn; Quyết định số 22/2006/QĐ-BTNMT ngày 18/12/2006, Thông tư số 12/2006/TT-BTNMT và Quyết định số 23/2006/QĐ-BTNMT ngày 26/12/2006 của Bộ Tài nguyên và Môi trường; Quyết định số 65/2007/QĐ-UBND ngày 11/12/2007 của UBND tỉnh Đồng Nai và các văn bản luật có liên quan khác; như sau:

a) Trong giai đoạn thi công, xây dựng dự án:

- Tổ chức thực hiện tốt các biện pháp thi công, xây dựng nhằm bảo đảm không gây ngập úng vào mùa mưa, gây ách tắt giao thông, gây lụt lỡ, rung nứt nhà dân và công trình công cộng.
- Thực hiện vệ sinh môi trường nhằm đảm bảo mỹ quan đô thị, ảnh hưởng đến sức khỏe cộng đồng, an toàn giao thông.
- Có biện pháp bảo đảm không phát tán bụi, tiếng ồn, độ rung, ánh sáng vượt quá tiêu chuẩn cho phép.
- Việc vận chuyển vật liệu thi công, xây dựng phải được thực hiện bằng các phương tiện bảo đảm yêu cầu kỹ thuật không làm rơi vãi, gây ô nhiễm môi trường và đảm bảo an toàn giao thông.
- Có nơi tập trung rác thải sinh hoạt bảo đảm vệ sinh môi trường. Thu gom, phân loại, xử lý toàn bộ các loại chất thải rắn, nước thải bảo đảm an toàn và vệ sinh môi trường theo quy định. Đối với chất thải nguy hại phải tuân thủ thực hiện đúng quy định quản lý về chất thải nguy hại.
- Thực hiện các biện pháp giảm thiểu, ngăn ngừa sự cố rò rỉ dầu nhớt thải.

b) Trong quá trình hoạt động dự án:

- Xây dựng và tách riêng triệt để tuyến thoát nước mưa, nước thải phù hợp với quy hoạch chi tiết được duyệt; xây dựng các hạng mục công trình thu gom, thoát nước thải, phạm vi thu gom, xử lý nước thải và xả nước thải sau xử lý phải phù hợp với Nghị định số 88/2007/NĐ-CP ngày 28/5/2007 của Chính phủ về thoát nước đô thị và khu công nghiệp và Quyết định số 1197/QĐ-UBND ngày 14/4/2008 của UBND tỉnh Đồng Nai về việc phê duyệt dự án hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa – giai đoạn 1. Nước thải sau khi thu gom phải được xử lý đạt Quy chuẩn kỹ thuật quốc gia về nước thải sinh hoạt QCVN 14:2008/BTNMT, cột B, K= 1,0 và các quy chuẩn kỹ thuật về môi trường hiện

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hành, trước khi xả thải ra nguồn tiếp nhận sông Đồng Nai. Tính toán điều tiết, điều hòa hợp lý chế độ xả nước thải vào nguồn tiếp nhận, tránh gây ngập úng cục bộ đảm bảo chế độ thủy văn và an toàn về môi trường. Bố trí cửa xả nước thải vào nguồn tiếp nhận phải đặt ở vị trí thuận lợi, minh bạch cho việc kiểm tra, giám sát, có lắp đặt thiết bị đo lưu lượng và quan trắc tự động các thông số ô nhiễm đặc trưng tại đầu ra hệ thống xử lý nước thải.

- Bùn thải từ hệ thống xử lý nước thải tập trung được quản lý theo quy định về quản lý chất thải rắn. Bùn thải có yếu tố nguy hại phải tuân thủ thực hiện đúng quy định quản lý về chất thải nguy hại.

- Khí thải phát sinh trong quá trình vận hành hệ thống xử lý nước thải tập trung phải được kiểm soát chặt chẽ đảm bảo đạt tiêu chuẩn Việt Nam về môi trường theo TCVN 5939: 2005 Cột B (ứng với $K_v = 1,0$; K_p theo tổng lưu lượng nguồn thải) và TCVN 5940:2005 trước khi thải vào môi trường. Đối với môi trường không khí xung quanh tuân thủ thực hiện theo TCVN 5937:2005, 5938:2005.

- Có kế hoạch tổ chức thực hiện về nhân lực, kinh phí, trang thiết bị bảo đảm phòng ngừa và ứng phó sự cố môi trường khi có sự cố xảy ra trong quá trình vận hành hệ thống xử lý nước thải tập trung. Không để sự cố gây tác động và ảnh hưởng đến con người, môi trường; đồng thời báo cáo kịp thời cho các cơ quan quản lý Nhà nước, các tổ chức có liên quan để phối hợp xử lý sự cố. Có bộ phận chuyên môn đủ năng lực để thực hiện nhiệm vụ bảo vệ môi trường của dự án. Thực hiện quan trắc định kỳ nước thải trước và sau khi xử lý với tần suất 04lần/năm và giám sát môi trường xung quanh với tần suất 02lần/năm. Số liệu quan trắc được lưu giữ làm căn cứ để kiểm tra, giám sát hoạt động của hệ thống xử lý nước thải tập trung.

3. Tuân thủ nghiêm túc chế độ thông tin, báo cáo về việc thực hiện nội dung của báo cáo đánh giá tác động môi trường đã được phê duyệt và các yêu cầu nêu tại Quyết định này theo quy định tại Nghị định số 80/2006/NĐ-CP ngày 09/8/2006 của Chính phủ về quy định chi tiết và hướng dẫn thi hành một số điều của Luật Bảo vệ môi trường.

4. Phối hợp chặt chẽ với chính quyền địa phương trong quy trình thi công, xây dựng và hoạt động dự án để bảo đảm an ninh trật tự; thực hiện chương trình tuyên truyền nâng cao nhận thức về bảo vệ môi trường đối với nhân dân địa phương, người lao động tham gia thi công, xây dựng và vận hành dự án; tuân thủ các quy định về an toàn hoá chất, phòng cháy, chữa cháy, ứng cố sự cố, an toàn lao động, tài nguyên nước và các quy định khác của pháp luật trong quá trình thi công xây dựng và hoạt động của dự án.

5. Dự án chỉ được phép đi vào hoạt động chính thức sau khi chủ dự án đã hoàn thành thực hiện các nội dung cam kết bảo vệ môi trường nêu trong báo cáo đánh giá tác động môi trường của dự án, các yêu cầu bảo vệ môi trường nêu trên và được cơ quan Nhà nước có thẩm quyền về môi trường kiểm tra, cấp giấy xác nhận theo quy định.

6. Chủ dự án hoàn toàn chịu trách nhiệm trước pháp luật khi để xảy ra các tác động xấu và sự cố môi trường trong quá trình thi công, xây dựng và hoạt động dự án.

Điều 3. Báo cáo đánh giá tác động môi trường của Dự án và những nội dung yêu cầu bắt buộc tại Điều 2 của Quyết định này là cơ sở để các cơ quan quản lý nhà nước về bảo vệ môi trường tiến hành kiểm tra, thanh tra việc thực hiện công tác bảo vệ môi trường của Dự án.

Điều 4. Trường hợp có những thay đổi về nội dung của Báo cáo đánh giá tác động môi trường được phê duyệt trong quá trình triển khai thực hiện Dự án, Chủ dự án phải có văn bản báo cáo và chỉ được thực hiện những nội dung thay đổi đó sau khi có văn bản chấp thuận của cơ quan quản lý nhà nước về bảo vệ môi trường có thẩm quyền.

Điều 5. Giao Sở Tài nguyên và Môi trường chủ trì phối hợp với UBND thành phố Biên Hòa, các cơ quan hữu quan có liên quan thực hiện giám sát, kiểm tra và xác nhận việc thực hiện các nội dung bảo vệ môi trường trong Báo cáo đánh giá tác động môi trường đã được phê duyệt và các yêu cầu bắt buộc nêu tại Điều 2 của Quyết định này.

Điều 6. Chánh Văn phòng UBND tỉnh, Giám đốc các Sở: Tài nguyên và Môi trường, Công thương, Xây dựng, Khoa học và Công nghệ, Giao thông Vận tải, Nông nghiệp và Phát triển nông thôn, Kế hoạch Đầu tư, Tài chính, Chủ tịch UBND thành phố Biên Hòa, Chủ dự án – Ban Quản lý Dự án thoát nước Đồng Nai thuộc Sở Xây dựng Đồng Nai và các tổ chức, cá nhân liên quan có trách nhiệm thi hành Quyết định này kể từ ngày ký./.

Nơi nhận:
-Như điều 6;
-Bộ Tài nguyên và Môi trường;
-TTTU, TTHĐND tỉnh (để b/c);
-Chủ tịch, các Phó Chủ tịch UBND;
-Chánh, Phó Văn phòng CNN;
- Lưu VT, TH (CNN, KT).
Thao.CNNQĐĐTM. thoatnuocbienhoa.18

KT.CHỦ TỊCH
PHÓ CHỦ TỊCH

Ao Văn Thinh

PEOPLE'S COMMITTEE OF DONGNAI PROVINCE

No: 426/QĐ-UBND

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom – Happiness

Bien Hoa, 23 Febuary 2008

DECISION

On the approval of the Environmental Impact Assessment Report of "Project on sewerage and wastewater treatment system in Bien Hoa City phase I" of Dong Nai Sewerage Project Management Unit under Dong Nai Construction Department

THE CHAIRMAN OF PEOPLE'S COMMITTEE OF DONGNAI PROVINCE

Pursuant to Law on the Organization of People's Council and People's Committee dated November 26, 2003;

Pursuant to the November 29, 2005 Law on Environmental Protection;

Pursuant to the Government's Decree No. 80/2006/ND-CP of August 9, 2006, detailing and guiding the implementation of a number of articles of the Law on Environmental Protection;

(21/2008/NĐ-CP)

Pursuant to the Government's ~~Decree No.59/2007/NĐ~~-CP of April 09, 2007 on solid waste management;

Pursuant to Circular 08/2006/TT-BTNMT on August 9,2006 of Ministry of Natural Resources and Environment, Guiding the strategic environment assessment, environmental impact assessment and environmental protection commitments; Circular 12/2006/TT-BTNMT on December 12/2006 of Ministry of Natural Resources and Environment, Guiding the practice conditions and procedures established profile, registration, licensing practice, code management harmful waste;

Pursuant to Decision 22/2006/QĐ-BTNMT on December 18/2006, Force application of Vietnam Criteria on environment; Decision 23/2006/QĐ-BTNMT on December 26/2006, Issued catalogue of harmful waste;

Pursuant to Decision 65/2007/QĐ-UBND on December 11/2007 of People's committee of Dong Nai province; Partition environment receiving wastewater and sewage gas industry in the Dong Nai province;

According to proposal of Commission assessment the environmental impact assessment report of "Project on sewerage and wastewater treatment system in Bien Hoa City phase I" of Dong Nai Sewerage Project Management Unit under Construction Department of Dong Nai Province in the meeting at March 20, 2008;

Considers contents of the Environmental impact assessment report of "Project on sewerage and wastewater treatment system in Bien Hoa City phase I" was modified and added at Explanation Documents No.103/BQLTN-BH on December 15, 2008 and No.04/BQLTN-BH on January 13/2009 of Dong Nai Sewerage Project Management Unit under Department of Construction of Dong Nai Province;

According to proposal of Director of Department of Natural Resources and Environment at Submission 12/2006/TTr-TNMT on February 16/2009;

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DECIDES

Article 1. To approval of the Environmental Impact Assessment Report of "Project on sewerage and wastewater treatment system in Bien Hoa City phase I" of Dong Nai Sewerage Project Management Unit under Department of Construction of Dong Nai Province (hereafter called the project owner).

Article 2. The project owner takes the responsibility to implement precisely the contents in this Environmental Impact Assessment Report and the following issues:

1. Comply with the Master Plan of project and Bien Hoa City approved by the authorities; comply with Vietnamese Construction Standard and other relevant regulations about greenery area, quarantine distance for sanitation of project.

2. During the constructing and operating progress, the project has to comply with the execution of environmental protection methods and assure the treatment solid waste to attain the Vietnamese Standard on Environment; Government's Decree No.59/2007/NĐ-CP of April 09, 2007 on solid waste management; Decision No 22/2006/QĐ-BTNMT dated December 18, 2006; Circular No 12/2006/TT-BTNMT and Decision No 23/2006/QĐ-BTNMT dated December 26, 2006 of Ministry of Natural Resources and Environment; Decision No 65/2007/QĐ-UBND dated December 11,2007 of People's Committee of Dong Nai Province and the other relevant documents as following items:

a) During the construction phase of project, the owner takes the responsibilities:

- To organize the construction methods reasonably, ensuring not to cause flood situation in the rain season, traffic jams, landslide, fissuring the resident's house and public structures.

- To implement the sanitary protection methods to insure the beauty of urban area, not to affect to public health and traffic safe.

- To ensure not to cause the dust, noisy, shake, light exceeding the criteria permission.

- To ensure material construction has to be transported by technical requirement vehicles not to cause the scatter, environmental pollution and safe traffic.

- To organize the area to collect household garbage in order to ensure the environmental sanitation; gather, classify and treat the solid waste, wastewater reaching the criteria as regulations. Especial the hazardous waste must be complied with the regulations on solid hazardous waste management.

- To minimize and prevent the scatter of lubricants.

b) During the implementation phase of project, the owner takes the responsibilities:

- To construct and separate strictly storm-water and wastewater systems in accordance to the approved detail planning; construct the inlet, outlet, determining the scope for collecting, wastewater treatment in accordance with Government's Decree 88/2007/NĐ-CP dated May 28, 2007 urban and industrial-park water drainage and Decision 1197/QĐ-UBND dated April 14, 2008 on the approval of project on sewerage and wastewater treatment system in Bien Hoa City phase I. The wastewater after collecting must reach the Vietnamese Standard on Wastewater at QCVN 14:2008/BTNMT, column B, K = 1,0 and other existing Technical Standards on Environment before being let out to Dong Nai River; to adjust reasonably the approach of letting out wastewater to outlets, to prevent the flood situation, to ensure the

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regulation of hydrogeology and environment; To arrange the outlets at the propitious location for authorities' inspection, supervision; To install the meter for determine the flow

- Sludge collected from the wastewater treatment systems has to be managed in accordance with the regulations on solid waste management. Sludge with hazardous waste must be complied with the regulations on solid hazardous waste management.

- Air raised from the operation of the wastewater treatment systems must be controlled strictly to ensure the Vietnamese Standard on environment according to TCVN 5939: 2005 Column B (equivalent to $K_V = 1,0$; K_P complied with total flow from waste source) and TCVN 5940: 2005 before let out to the environment. The surrounding air must comply with TCVN 5937: 2005, 5938: 2005.

- To organize the plan for human resources, cost, equipments to ensure, prevent and encounter with environmental problems happening during the operation of wastewater treatment systems; to prevent the hazard from affecting human and environment; to report opportunely to governmental offices, relevant offices to solve the problems; to arrange the competent employers to carry out the environmental protection of the project; to implement the observational measurement regularly for wastewater before and after treatment with the frequency of 04 times/year, monitoring and testing environment with frequency, 02 times/year. The observational measurement data will be archived as basically for inspection, supervision the Wastewater treatment system focus activities.

3.Comply with stringent information regime, report, requirements on the implementation of the contents of the Environmental Impact Assessment Report approved according to Government's Decree 80/2006/NĐ-CP on August 09/2006, detailing and guiding the implementation of a number of articles of the Law on Environmental Protection;

4. Coordinate closely with local government in construction process, construction and project activities to ensure order and security; organizations, in implementing the advocacy to raise awareness of environmental protection for local people, the labor participation of construction, building and operating project; Comply with chemicals safety regulations, fire protection, extinguish the fire and the processing problems, labor safety, water resources and other provisions of law in the implementation of construction and operation project;

5. Project is permitted to come in action only after the Project owner is executive environmental protection engagement contents in the Environmental Impact Assessment Report, the requirements of environmental protection have already been pointed above and State agencies have jurisdiction about environment checks, confirming order bestowal according to ordinance;

6. Project owner entirely responsible before the law when happening to the impact of evil and environmental problems in the implementation of construction and operation project.

Article 3. The Environmental Impact Assessment Report of project and content requirements required in Article 2 in this Decision is the basis for state agencies conducting inspection, inspection of the implementation of environmental protection project.

Article 4. In case has changes in the contents of the Environmental Impact Assessment Report was approved in the implementation of the project, Project owner must have a written report and only make changes when have legal documents of the government authorities.

Article 5. Department of Natural Resources and Environmental preside collaboration with People's Committee of Bien Hoa city, the agencies supervise, checking and verification of the implementation of the contents of the Environmental Impact Assessment Report was approved and content requirements required in Article 2 in this Decision.

Article 6. District office committees of provinces and Director of departments: Natural Resources and Environment, Industry and Commerce, Construction, Science and Technology, Transportation, Agriculture and Rural Development, Planning and Investment, Finance, Chairman of people's committee of Bien Hoa City, project owner – Dong Nai Sewerage Project management unit under Department of construction of Dong Nai province and other organizations and individuals are responsible for the implementation of this Decision as of from the date of signing./.

FOR CHAIRMAN
VICE CHAIRMAN
(Signed and Sealed)
Ao Van Thinh

C/c:
- As Article 6;
- Ministry of Natural Resources and Environment;
- Provincial Party Committee, People's Council (for report)
- Chairman, Vice Chairman of People's committee;
- Chief, Deputy Chief of CNN office;
- Saved Document division, General division (CNN,KT).

4

Appendix 10-B

Dong Nai PC's Comment on EIA

PEOPLE'S COMMITTEE OF	**SOCIALIST REPUBLIC OF VIETNAM**
DONG NAI PROVINCE	**Independence- Freedom- Happiness**
No. 762/UBND-CNN	*Bien Hoa, January 25th, 2011*

Re.: Extension of validity period of the Decision on approval of EIA report for the Project on Sewerage and Wastewater Treatment System for Bienhoa City Phase I

To: - Dong Nai Management Unit for Sewerage Projects (PMU)

Pursuant to the Decree No. 80/2006/ND-CP dated August 09, 2006 of the Government detailing and guiding the implementation of a number of articles of the Law on Environmental Protection; the Decree No. 21/2008/ND-CP dated February 28, 2008 of the Government amending and supplementing a number of articles of the Decree No. 80/2006/ND-CP dated August 09, 2006 of the Government;

After taking into consideration of the proposal by Department of Natural Resources and Environment of Dong Nai Province in the document No. 81/TNMT/CCBVMT dated 14/01/2011 and the document No. 341/BQLTN dated 09/12/2010 of PMU regarding request for extension of validity period of the Decision on approval of EIA report for the Project on Sewerage and Wastewater Treatment System for Bienhoa City Phase I, Chairman of People's Committee of Dong Nai Province (Dong Nai PC) has comments as follows:

1. The Decision No. 426/QD-UBND dated February 23, 2009 by the Dong Nai PC on approval of EIA report for the Project on "Investment for Construction of Sewerage and Wastewater Treatment System for Bienhoa City, Phase I" has no changes in project location, scope, capacity and technology as compared to the content of the appraised and approved EIA report, thus, PMU is not required to apply for extension of its validity.

2. In case the above-said project is carried out after 24 months from the date of approval of EIA report, without changes in project location, scope, capacity and technology, PMU is not required to prepare supplementary EIA report, however, must submit an explanation letter to competent State agencies at the commencement of the project implementation in accordance with the regulation at Item 6, Article 1 of the Decree No. 21/2008/ND-CP dated February 28, 2008 of the Government./.

FOR CHAIRMAN

VICE CHAIRMAN

(Signed and sealed)

Ao Van Thinh

Recipients:
- As ditto;
- Chairperson, Vice Chairpersons of Dong Nai PC;
- Dong Nai DONRE;
- Chief Administrator, Deputy Chief Administrators of CNN;
- Archives: Office, CNN

ỦY BAN NHÂN DÂN
TỈNH ĐỒNG NAI

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập – Tự do – Hạnh phúc

Số: 762 /UBND-CNN

Biên Hòa, ngày 25 tháng 01 năm 2011

V/v gia hạn thời gian hiệu lực của Quyết định phê duyệt báo cáo đánh giá tác động môi trường dự án hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa giai đoạn 1.

BQL.DỰ ÁN THOÁT NƯỚC ĐN
CÔNG VĂN ĐẾN
SỐ: 13
NGÀY: 27/1/2011

Kính gửi: Ban Quản lý dự án thoát nước Đồng Nai.

Căn cứ Nghị định số 80/2006/NĐ-CP ngày 09/08/2006 của Chính phủ về việc quy định chi tiết và hướng dẫn thi hành một số điều của Luật Bảo vệ môi trường; Nghị định số 21/2008/NĐ-CP ngày 28/02/2008 của Chính phủ về sửa đổi, bổ sung một số điều của Nghị định số 80/2006/NĐ-CP ngày 09/08/2006 của Chính phủ;

Sau khi xem xét nội dung kiến nghị của Sở Tài nguyên và Môi trường tại Văn bản số 81/TNMT-CCBVMT ngày 14/01/2011 và Văn bản số 341/BQLTN ngày 09/12/2010 của Ban Quản lý dự án thoát nước Đồng Nai về việc gia hạn thời gian hiệu lực của Quyết định phê duyệt báo cáo đánh giá tác động môi trường dự án hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa giai đoạn 1; Chủ tịch UBND tỉnh có ý kiến như sau:

1. Quyết định số 426/QĐ-UBND ngày 23/02/2009 của UBND tỉnh Đồng Nai phê duyệt báo cáo đánh giá tác động môi trường Dự án "Đầu tư xây dựng hệ thống thoát nước và xử lý nước thải thành phố Biên Hòa - giai đoạn 1" không có sự thay đổi về địa điểm, quy mô, công suất và công nghệ của dự án so với nội dung Báo cáo đánh giá tác động môi trường đã được thẩm định, phê duyệt. Do đó, Ban Quản lý dự án thoát nước Đồng Nai không phải thực hiện gia hạn hiệu lực.

2. Trong trường hợp dự án nói trên triển khai sau 24 tháng kể từ ngày báo cáo đánh giá tác động môi trường được phê duyệt không có sự thay đổi về địa điểm, quy mô, công suất và công nghệ của dự án thì Ban Quản lý dự án thoát nước Đồng Nai không phải lập báo cáo đánh giá tác động môi trường bổ sung, nhưng phải có văn bản giải trình với cơ quan nhà nước có thẩm quyền khi bắt đầu triển khai dự án theo quy định tại Khoản 6, Điều 1 Nghị định số 21/2008/NĐ-CP ngày 28/02/2008 của Chính phủ./.

KT. CHỦ TỊCH
PHÓ CHỦ TỊCH

Võ Văn Thinh

Nơi nhận:
- Như trên;
- Chủ tịch, các Phó Chủ tịch UBND tỉnh;
- Sở Tài nguyên và Môi trường;
- Chánh, Phó Văn Phòng CNN;
- Lưu: VT, CNN.

Thaocnn. suahanglaiDTM-BQLDuanthoatnuoc.

Số 02, Nguyễn Văn Trị, P. Thanh Bình, TP. Biên Hòa

Appendix 10-C

Confirmation for EIA Requirement

DONG NAI CONSTRUCTION DEPARTMENT
PMU FOR SEWERAGE PROJECTS.

THE SOCIALIST REPUBLIC OF VIET NAM
Independence – Freedom – Happiness

Bien hoa, April 6th, 2011

No.: 63A/BQLTN

Re: comment of PMU on the supplementary EIA.

To: Phase II JICA study team for the Project on Sewerage and Wastewater Treatment for Bien Hoa City, phase I

PMU for Dong Nai sewerage projects received the letter No. DNWEIP/11009 from JICA study team regarding confirmation on the supplementary EIA report for the Project on Sewerage and Wastewater Treatment for Bien Hoa City, phase I. After checking the related documents, PMU hereby comments as follows:

As stipulated in the Clause 6, Article 1 of the Decree No. 21/2008/NĐ-CP dated February 28th, 2008 on amendment, supplement some Articles of the Decree No. 80/2008/NĐ-CP dated August 9th, 2006 of the Government on detailed regulations and implementation guidance of law on environmental protection, the supplementary EIA may be prepared for the following cases:

- Changes on design capacity;
- Changes on technology;
- Changes on surrounding environment.

After checking and comparison, PMU realized that there was no change on the data provided by JICA study team compared with the approved EIA because of the following reasons:

- The final purpose of the project is to invest the Sewerage and Wastewater Treatment for the whole scope of phase I, included 20 wards of Bien Hoa City, so the approved EIA report had been calculated the EIA for the whole scope of phase I. It meant that the whole priority area was included as studied by the JICA study team.
- Due to limited financial condition, therefore the investment in this phase shall be focused on the priority area of phase I. PMU for Dong Nai sewerage projects shall continue arrangement of the financial source to complete the investment for the whole project. Therefore, the investment for this phase is just one part in the approved EIA report, and there is no change on project location, scope, and capacity, technology compared with the approved EIA.

Those were comments on the supplementary EIA for the Sewerage and Wastewater Treatment for Bien Hoa City, phase I from PMU for Dong Nai sewerage projects. Your attention would be highly appreciated.

DIRECTOR

C/c:
- As above;
- File.

Pham Van Binh
(signed and sealed)

Appendix 10-D

EIA Appendix List

Appendix 1: The related legal documents

- Letter No. 5905/UBND-CNN dated July 23rd, 2008 concerning request on carrying out the next procedures for the sewerage system of Bien Hoa City, phase I up to 2010.
- Letter No. 1197/QĐ-UBND dated April 14, relating to approval for the Project on sewerage and wastewater treatment for Bien Hoa City, phase I (attached the Appendix No. 1197).
- Letter No. 206/BXD-KSTK dated February 1st, 2008 regarding to basic design assessment result (Project on sewerage and wastewater treatment for Bien Hoa City, phase I).
- Agreement No. 09/HĐ-XD of Consulting for preparation of F/S for Project on sewerage and wastewater treatment for Bien Hoa City, phase I. (signed on September 14th, 2006).
- Letter No. 3825/UBND-CN dated June 28th, 2005 relating to F/S for Project on sewerage and wastewater treatment for Bien Hoa City, phase I.
- Letter No. 69/ICC-WRC concerning survey, F/S preparation, EIA report for project on sewerage and wastewater treatment for Bien Hoa City, phase I.
- Letter No. 21/BQLTN dated September 6th, 2004 regarding acceptance for the sub-consultant nominated by the Water Research Co., Ltd.
- Letter on project record support for drainage and wastewater treatment of Bien Hoa City.
- Letter No. 1437/CV-UBT dated March 22nd, 2004 concerning proposal for listing the project into the ODA mobilization list in 2004.

Appendix 2: Comments of the communities in the project area

- Public consultation documents for EIA contents.
- Public consultation of each ward for project area.
- Comments on EIA of Project on sewerage and wastewater treatment for Bien Hoa City.

Appendix 3: Monitoring results for environment quality

- Test results for from Ministry of Defence (Including: Sample name, sample position, sample collector, sample method, and date of sample collection).

Appendix 4: Drawings

- Layout plan of stormwater system.
- Layout plan of wastewater system.
- Wastewater treatment plant No. 1 (Diagram of technology line)
- Wastewater treatment plant No. 1 (General layout)
- Wastewater treatment plant No. 1 (Location plant)
- Wastewater treatment plant No. 2 (Diagram of technology line)
- Wastewater treatment plant No. 2 (General layout)
- Wastewater treatment plant No. 2 (Location plant)

Appendix 10-E

The Changed Contents of EIA

THE CHANGED CONTENTS OF EIA

No	Content	Current EIA	Supplemental EIA
A	***GENERAL INFORMATION***		
1	Tile project	Project on Sewerage and Wastewater treatment for Bien Hoa city in phase I	Project on Sewerage and Wastewater treatment for Bien Hoa city in phase I
2	Target Year	2010	2020
3	The population on project area	Proposed at 2010: 420,952 persons	
		Proposed at 2020: 469.550 persons	Proposed at 2020: 188,000 persons
4	The project area	3,635 ha	1,072 ha
5	Proposed investment capital	159.8 million USD (JICA: 122.1 million USD; Vietnam: 37.7 million USD)	**To review and define later**
6	Demanded manpower in O&M	100 person	**To review and define later**
7	Schedules of construction	From September 2007 to December 2010	**To review and define later**
B	***SEWAGE TREATMENT PLANT NO.1***		***Next phase***
1	Capacity of STP No.1	2010: 9,500 m3/day	-
		2020: 19,000 m3/day	-
2	The population on service area of STP No.1	2010: 75,533 person	-
		2020: 124,131 person	-
3	The location of STP No.1	Area: 9.7 ha Location: at Ho Nai ward	-
4	Treatment technology	Biological treatment (Circulating activated sludge)	-
5	Sludge treatment	Gravity Thickener and Dewatering by sludge pressing machine	-
6	Requirement of treatment level	- BOD5 < 20 mg/l - SS = 50 mg/l	-
7	Water supply standard	2010: 150 lit/capita.day	-
		2020: 165 lit/capital. Day	-
8	Wastewater backflow	80%	-

No	Content	Current EIA	Supplemental EIA
9	Influent quality of domestic wastewater	- pH: 6.5 to 7.5; - SS: 200 to 250 (mg/l); - BOD5: 150 to 200 (mg/l); - COD 300 to 350 (mg/l); - Total Coliform 106 to 107 MPN/100ml	-
10	Parameters for Management of Effluent Quality	- pH: 5 to 9; - SS: 50 mg/l; - BOD5: 30 (mg/l); - Sulphuret: 1.0 mg/l; - Ammonium: 5 mg/l; - Nitrate: 30 mg/l; - Phosphate; 6 mg/l; - Oil, petroleum, grease, pat: 10 mg/l; - Coliform: 3000 MPN/100 ml	-
11	Architectural form	Industrial buildings with low-rise	-
C	***SEWAGE TREATMENT PLANT NO.2***		
1	Capacity of STP No.2	2010: 52,000 m3/day	
			2020: 41,500 m^3/day
2	The population on service area of STP No.2	2010: 345,419 person	
			Proposed at 2020: 188,000 persons
3	The location of STP No.2	Area: 9.342 ha Location: at Tam Hiep ward	Area: 9.342 ha Location: at Tam Hiep ward
4	Treatment technology	Biological treatment (Circulating Activated Sludge)	Biological treatment (Circulating Activated Sludge)
5	Sludge treatment	Gravity Thickener and Dewatering by sludge pressing machine	Gravity Thickener and Dewatering by sludge pressing machine
6	Requirement of treatment level	- BOD5 < 20 mg/l - SS = 50 mg/l	BOD5 < 30 mg/l SS < 30 mg/l
7	Water supply standard	2010: 150 lit/capital.day	
			2020: 165 lit/capital.day
8	Wastewater backflow	80%	80%

No	Content	Current EIA	Supplemental EIA
9	Influent quality of domestic wastewater	- pH: 6.5 to 7.5; - SS: 200 to 250 (mg/l); - BOD5: 150 to 200 (mg/l); - COD: 300 to 350 (mg/l); - Total Coliform 106÷107 MPN/100ml	- BOD5: 200 mg/l - SS: 250 mg/l - T-N: 48 mg/l - T-P: 7.6 mg/l
10	Parameters for Management of Effluent Quality	- pH: 5 to 9; - SS: 50 mg/l; - BOD5: 30 (mg/l); - Sulphuret: 1.0 mg/l; - Ammonium: 5 mg/l; - Nitrate: 30 mg/l; - Phosphate; 6 mg/l; - Oil, petroleum, grease, pat: 10 mg/l; - Coliform: 3000 MPN/100 ml	- pH: 6 to 9; - SS: 50 mg/l; - BOD5: 30 (mg/l); - Sulphuret: 1.0 mg/l; - Ammonium: 5 mg/l; - Nitrate: 30 mg/l; - Phosphate; 6 mg/l; - Oil, petroleum, grease, pat: 10 mg/l; - Coliform: 3000 MPN/100 ml
11	Architectural form	Industrial construction with low-rise	Industrial construction with low-rise
D	***SEWAGE PUMPING STATION***		
1	Pumping Station No. 1	Capacity of pumping (2010): 19,900 m3/day	Capacity of pumping (2020): Combined System Area: 20,000 m^3/day Separate System Area: 1,300 m^3/day Total: 21,300 m^3/day
		Quantity of Pumping: 3 pcs (2 working, 1 stan-by)	Quantity of Pumping: 4 pcs (2 working, 2 stan-by)
		Area of used land: 9.8 m x 14.8 m	Area of used land: 80 m x 80 m
		Location: Vo Thi Sau road (Quyet Thang ward)	Location: Vo Thi Sau road (Quyet Thang ward)
		Architectural form: Underground construction	Architectural form: Underground construction
2	Pumping Station No. 2 (2010)	Capacity of pumping: 1,700 m3/day	*Next phase*
		Quantity of Pumping: 3 pcs	-
		Area of used land: 5.1 m x 6.6 m	-
		Location: Dong Nai riverside (Buu Long ward)	-
		Architectural form: Underground construction	-

No	Content	Current EIA	Supplemental EIA
3	Pumping Station No. 3 (2010)	Capacity of pumping: 3,100 m3/day	*Next phase*
		Quantity of Pumping: 3 pcs	-
		Area of used land: 5.1 m x 8.15 m	-
		Location: nearby Lung ditch(Buu Long ward)	-
		Architectural form: Underground construction	-
4	Pumping Station No. 4 (2010)	Capacity of pumping: 6,300 m3/day	*Next phase*
		Quantity of Pumping: 3 pcs	-
		Area of used land: 6.8 m x 15.3 m	-
		Location: Tan Phong ward	-
		Architectural form: Underground construction	-
5	Pumping Station No. 5	Capacity of pumping (2010): 52,100 m3/day	Capacity of pumping (2020): Combined System Area: 20,000 m^3/day Separate System Area: 22,000 m^3/day Total: 42,000 m^3/day
		Quantity of Pumping: 6 pcs	Quantity of Pumping: 5 pcs (3 working, 2 stan-by)
		Area of used land: including STP area	Area of used land: including STP area
		Location: Tam Hiep ward	Location: Tam Hiep ward
		Architectural form: Underground construction	Architectural form: Underground construction
6	Pumping Station No. 6 (2010)	Capacity of pumping: 9,700 m3/day	*Next phase*
		Quantity of Pumping: 3 pcs	-
		Area of used land: 6.8 m x 14.9 m	-
		Location: Tan Hiep ward	-
		Architectural form: Underground construction	-
E	***SEWAGE PIPES***		
1	Gravity sewage system		
	Ø300-Ø800 Reinforced concrete pipes (depth < 3m)	Total length: 104,432 m	Ø300-Ø800 PVC, HDPE pipes (depth < 3m) Total length: 2,347 m
	Ø300-Ø800 Reinforced concrete pipes (depth > 3m)	Total length: 17,000 m	Ø300-Ø1500 Reinforced concrete, PVC, HDPE pipes (depth > 3m) Total length: 12,381 m

No	Content	Current EIA	Supplemental EIA
2	Pressure sewage system		
	Ø300-Ø800 HDPE pipes	Total length: 2,121 m	Ø100-Ø200 DCIP pipes Total length: 2,101 m
3	Manholes		
	Ø300-Ø800 Manhole (depth < 3m)	Total: 4819 pcs	Ø100-Ø200 DCIP pipes Total length: 2,621 m
	Ø300-Ø800 Manhole (depth > 3m)	Total: 603 pcs	Ø300-Ø800 Manhole (depth < 3m) Total: 108 pcs
4	Overflow chambers		
	Ø800-Ø1500 Overflow chambers (depth < 3m)	Total: 7 pcs	Ø300-Ø1,500 Manhole (depth > 3m) Total: 439 pcs
	3000mm x 2500mm Overflow chambers (depth < 3m)	Total: 1 pcs	2,000mm x 2,000mm Overflow chambers (depth < 3m) Total: 2 pcs
	Ø600-Ø1800 Overflow chambers (depth > 3m)	Total: 7 pcs	Ø3,000mm x 2,500mm Overflow chamber (depth > 3m) Total: 1 pcs
F	***STORM-WATER DRAINAGE PIPES***		
1	Ø300-Ø1800 Reinforced concrete pipes	Total: 233,435 m	Ø600-Ø2,300 Reinforced concrete pipes Total: 45,880 m
2	Reinforced concrete box culvert (1600x2000 mm; 2000x2000 mm; 2000x2500 mm)	Total: 1660 m	Reinforced concrete box culvert (2000x2000 mm; 2,500x2,500 mm; 3,000x3,000 mm) Total: 1,655m
3	Reinforced concrete Manholes	Total: 6,619 pcs	Total: 1,339 pcs
4	Reinforced concrete Intakes	Total: 11,856 pcs	Total: 2,401 pcs
G	ENTIRE REHABILITITATION OF STREAMS/DITCHS		
1	Lung ditch	Total length: 1,570 m	*Next phase*
2	Bien Hung ditch	Total length: 680 m	Changed and included to drainage pipe
3	Dien Hong ditch	Total length: 1,320 m	Total length: 374 m
4	San Mau stream	Total length: 9,305 m	Total length: 9,194 m
5	Linh Bayou and Stream	Total length: 2,260 m	Linh Bayou: 2,214 m / Linh Stream: 1,155m
6	Ong Gia stream	Total length: 2080 m	*Next phase*

No	Content	Current EIA	Supplemental EIA
H	***PARTIAL REHABILITITATION OF STREAMS/DITCHS***		
1	Compensation for site clearance, and improvement of the operation corridor of Tan Mai stream	Total length: 2,150 m	*Next phase*
2	Compensation for site clearance, and improvement of the operation corridor of Ba Bot stream	Total length: 920 m	*Next phase*
I	***BRIDGE and ROAD CONSTRUCTION***		Already included in the current EIA

Appendix 11-A

Resettlement Action Plan

Plan for compensation, support resettlement

Bien Hoa city Drainage system and WWTP Project – Phase I

Plan for compensation, support resettlement
Bien Hoa city Drainage system and WWTP Project – Phase I

Table of Contents

PART A: PLAN OF IMPLEMENTATION OF COMPENSATION, SUPPORT AND RESETTLEMENT OF BIEN HOA CITY DRAINAGE SYSTEM AND WASTEWATER TREATMENT PLANT PROJECT - THE FIRST PERIOD

I. INTRODUCTION PROJECT

I.1 General information

Bien Hoa City is one of the most long-standing development cities in the Southeast of Vietnam. At present, it is the economic - cultural - social center of Dong Nai province, and a big industrial City of the country as well as a center of the key economic area in the South of Vietnam include Ho Chi Minh, Dong Nai and Vung Tau cities. Bien Hoa City is far from Ho Chi Minh City about 30 km and Vung Tau City about 90 km, is the important traffic clue of the Southern economic area and the Southeast of Vietnam with railway, national roads (National Road No. 1, National Road No. 51, Asian road, Highway); the City also plays a strategic role in the national safety and defense of the region.

Bien Hoa is the City of Class II in Vietnam which has twenty three wards and seven communes; 264.08 km^2 in area, the population about 784,398 people (according to the statistic of 2010).

I.2 Necessary of investment

Nowadays, Bien Hoa City has an old, backward and downgraded water sewerage system, as well as the worse environmental sanitation such as:
General most of the water sewerage systems had been built before 1975. Sewer network and concrete slab cover ditches use efficiently just 40%.

Capacity of sewerage (Domestic wastewater sewerage and storm water drainage) is unsafe that does not respond the developing requirement of the city at the present and in the future.

Domestic and industrial wastewater untreated has polluted Dong Nai River that is the main source of raw water for fresh water supply for Bien Hoa City and Ho Chi Minh City. Especially, the wastewater from the Industrial Zone of Bien Hoa I, markets, and Tan Mai Paper Mill has badly effected on the quality of fresh water, environment, and scenery.

Because of limited budget, sewer network maintenance had not been carried out frequently that made it not only lacked but also decreased in capacity.

Currently, the transport network in the City is improved; therefore, the water drainage must be improved with long-term objectives to synchronize with the above technical infrastructure.

For all the above reasons, there arises an urgent need for adequate and suitable plan to solve the problem of wastewater and storm water drainage generally, from designing sewerage calculation, management, and organization to frequently maintenance in order to meet the development of the Bien Hoa City to the year 2020.

I.3 Objective investment

Improvement and construction of wastewater sewerage and treatment system for Bien Hoa City of Dong Nai province to the year 2015 (phase 1) with the purpose of completing its infrastructure, reducing flood situations and improving the public health, making beautiful scenery to appeal tourists, attracting foreign investors in industrial zones such as: Bien Hoa 2, Long Binh, Amata, etc. The plan includes:

Proposal solutions for construction of a modern and suitable drainage and wastewater treatment plants for Bien Hoa City by the year 2015 to avoid flooding situations, protecting the surface water and ground water from being polluted by wastewater, improving public life, and contributing to local economic growth;

In the long- term, the project should be implemented with the following aims:

+ Complying the national domestic sewerage strategy;
+ Satisfying the development demands of City;
+ Reducing or eliminating flooding situations; increasing the value of land;
+ Eliminating the damages to the local people's and the state's properties;
+ Assisting in economic development;
+ Improving environmental and sanitation conditions; surroundings and public health;
+ Improving surface water quality.

I.4 Tasks and range of Project

Construction and improvement of storm water drainage and wastewater treatment includes: sewer networks (to tertiary level) that will be discharged by wastewater and storm water, wastewater pumping stations and wastewater treatment plants will be built in order to treat absolutely the whole wastewater (reach to A level) before discharging into water received sources.

Following the general planning for the whole Bien Hoa City to 2020 and the Pre-F/S report which was approved by the Prime Minister of Government, was divided phases and range of implementation for each specific stage are mentioned as follows: the first phase includes five (05) centre wards and two (02) sides' ones. However, when the F/S report is prepared, these side wards have been urbanized rapidly. These areas have population density and coating over their surfaces very high. In addition, their drainage and sewerage infrastructure has almost not existed or they existed but they haven't been synchronized. Therefore, investment in a synchronous drainage and sewerage system for these areas is very necessary in the phase. This is reason why the water drainage PMU requested the consultant to study and propose expansion of project range to twenty wards of the City in this phase and remaining wards of the City will be invested in the second phase.

Phase I of the service range of the Bien Hoa City drainage system and wastewater treatment Project was approved by the People's Committee of Dong Nai province in the Decision No.1197/QD-UBND in 04/14/2008 which consists of twenty wards of Bien Hoa City with total natural area of approximately 3,635 ha.

However, through the process of working with the JICA study group, Dong Nai water drainage PMU also agreed with JICA about prior Phase I from 2010-2015, include nine wards of Bien Hoa City such as: Quang Vinh, Quyet Thang, Tam Hiep, Tan Mai, Tan Tien, Thanh Binh, Thong Nhat, Trung Dung, Hoa Binh.

The industrial area have to have water drainage systems and wastewater treatment to treat wastewater reach regulation before being discharged into reception or common drainage system of city.

I.5 Size of construction investment

Construction of Bien Hoa City drainage systems and WWTP in phase I prior to nine wards of Bien Hoa City: Quang Vinh, Quyet Thang, Tam Hiep, Tan Mai, Tan Tien, Thanh

Binh, Thong Nhat , Trung Dung, Hoa Binh.

I.6 Plan of construction

Storm water drain: use of rubber joins connected reinforced - concrete culverts each other.

Wastewater drain: the type of drain which DN ≤ 500 uPVC materials is connected by rubber joints or sketch, 800 ≥ DN > 500 type HDPE material is joined by heat welding methods, ≥ DN 800 reinforced - concrete material with corrosion inhibiting admixture, is connected by rubber joints. Sewer that connects from the household sewer to the common drainage of city is PVC 100mm drain. Manholes are built by reinforced – concrete.

Wastewater pumping station: reinforced - concrete structures, underground, trash screens equipped with stainless steel.

Wastewater treatment plant: reinforced - concrete structures.

I.7 Main items of project

I.7.1 Restoration ditch, spring

Bien Hung ditch: renovate and build the box reinforced concrete culverts, b x h section = 1.6 m x 2 m, 680m length.

Dien Hong ditch: renovate and build the box reinforced concrete culverts, b x h section = 4m x 2m, about 820m length. Two stone embankment approximate 8,941m length, and ditch – bed has 15m width, height 2.5m, m = 1 of pent roof.

San Mau spring: dredge and rock dike on both sides edge of San Mau spring in the overhead, the bottom has 5 m to 7.5 m width, 1.8 m to 2.2 m height, roof tilt m = 1, a length of 6.225m, dredge and rock dike on both sides edge of the branch of San Mau spring, the bottom has 2 m to 7.5 m width, 1 m to 2.5 m height, pent roof m = 1, 3,080m length.

The branch of Linh spring: renovate and rock dike on both sides edge of the branch of Linh spring, the bottom has 3m width, 2m height, pent roof m = 1, 2,080m length (the branch of Linh spring which through Tam Hoa ward is 1,060 m length, through Binh Da ward is 1,151 m length)

I.7.2 Construction storm water drainage system

Construction of storm water drainage system with a total length of 60 km is task for the whole range of research projects in the prior Phase I.

I.7.3 Build sewage systems proposed include:

+ The main drain has about 20 km length
+ Branch of drains has abou 30 km length
+ The level 3 of drains has abou 170 km length
+ Wastewater Treatment Plant No. 1 will be built at Tam Hiep ward, estimated capacity: 36,000 m3/day
+ 02 pumping stations: No. 1 pump station at Thong Nhat ward; No. 3 at Tam Hiep ward.

II. PROJECT IMPACTS

II.1 Project affected people

People who affected by the project are the people is affected by land acquisition project at the time of closing inventory status and this leads to;

+ Relocation to other place or loss of residential area.
+ Loss of asset or loss of access to assets.
+ Loss of income or means of living, regardless they have to move to new place or not.

II.2 Main impact of the project

+ Permanently withdraw about 40 ha of land permanently for the project, area long-term damage to the building of wastewater treatment plant, booster pumping stations, dredging and improvement of streams.
+ Affecting people's lives.
+ Rebuilding or damage to housing.
+ Damages to property or rights to use assets.
+ Loss of income or loss of livelihood, affected people have to move to new settlements or.
+ The impact can occur during the construction process.

Assessing the impact of the project

Since August 2008, when the technical proposals are approved, the survey activities about cleared, relocation and resettlement in the project area have been made. The data in the table below are estimated by the basis of proposed basic design stage. These figures may change in the next phase of the project when conducting detailed design.

Table 1: The preliminary estimate of households affected

No.	Name of Ward	Categories	No. of affected households (HH)	No. of Displace Household (HH)
1	Binh Da	Linh stream	181	12
2	Tam Hoa	Linh stream	84	11
3	Trung Dung	Bien Hung ditch	14	8
4	Quyet Thang	Bien Hung ditch	38	10
5	Thong Nhat	Dien Hong ditch (channel)	24	0
6	Tan Hoa	San Mau stream (3600m)	127	19
7	Tan Bien + Ho Nai	San Mau stream (3600m)	198	5
8	Ho Nai + Trang Dai	San Mau stream (2625m)	83	0
9	Ho Nai + Tan Hiep	San Mau stream (715m)	34	0
10	Ho Nai	San Mau stream (470m)	19	0
11	Ho Nai	San Mau stream (1325m)	54	0
12	Ho Nai + Tan Hiep	San Mau stream (625m)	56	0
13	Tam Hiep	STP No. 2	13	75

	Total		925	140

Table 2: Cost Estimate on Compensation for Wastewater Treatment Plant

Tam Hiep Ward, Bien Hoa City

No.	Property	Unit	Quantity
1	TC.VT3 land - Pham van thuan Road	M2	8.063,4
2	TC.VT4 land - Pham van thuan Road	M2	14.525,3
3	Agricultural land	M2	7.047,8
4	Aquatic land	M2	3.447,9
6	C3H2 house	M2	80
7	C3H3 house	M2	140
8	C3H4 house	M2	40
9	C4H2 house	M2	890
10	C4H3 house	M2	672
11	C4H4 house	M2	7.161,5
12	Temporary house	M2	3.721,0
13	Wall	M2	1.019,0
14	Eaves	M2	172
15	Cement yard	M2	470
16	Concrete yard	M2	325
17	Pond	unit	84
18	Fish Pond	unit	40
19	Pigpen	unit	315
20	Electricity meter (main)	unit	68
21	Water meter (main)	unit	68
22	Telephone	unit	68

Note: TC: residential land; VT3: 3^{th} ranked location of plot; C3H2 house: 3^{th} ranked house which is located at 2^{nd} ranked lane.

Table 3: ESTIMATION OF COMPENSATION AMOUNT FOR LAND ACQUISITION FOR CONSTRUCTION OF PS No. 1 AND RENOVATION OF STREAMS

No.	NAME OF PROPERTY	UNIT	QUANTITY
1	TC. VT4 land - Ha Huy Giap Road (Rach Cat Bridge to Vo Thi Sau Road)	m^2	3.269.5
2	TC.VT3 land - Ha Noi Highway (Cau Sap bridge to boundary of Dong Nai province)	m^2	3.215.6
3	TC.VT4 land - Ha Noi Highway (Cau Sap bridge to boundary of Dong Nai province)	m^2	2.053.7
4	TC.VT1 land - Hung Dao Vuong Road (5 Bien Hung Crossroad to Bien Hoa Raiway station)	m^2	717.9
5	TC.VT3 land - Hung Dao Vuong Road (5 Bien Hung Crossroad to Bien Hoa Raiway station)	m^2	2.650.3
6	TC.VT1 land - Tran Quoc Toan Road (Vu Hong Pho to end of Tran Quoc Toan Road)	m^2	625.7

7	TC.VT2 land - Tran Quoc Toan Road (Vu Hong Pho to end of Tran Quoc Toan Road)	m^2	1.788.4
8	TC.VT4 land - Tran Quoc Toan Road (Vu Hong Pho to end of Tran Quoc Toan Road)	m^2	2.140.4
9	TC.VT1 land - Ha Noi Highway (alley side Ha Noi Parish (right) - market side Fourth ward (right) to Sap Bridge	m^2	811.6
10	TC.VT2 land - Ha Noi Highway (alley side Ha Noi Parish (right) - market side Fourth ward (right) to Sap Bridge	m^2	2,617.3
11	TC.VT4land - Ha Noi Highway (alley side Ha Noi Parish (right) - market side Fourth ward (right) to Sap Bridge	m^2	1,519.2
12	Land TC.VT1- Nguyen Ai Quoc road (Tan Phong crossroad to 30/4 park)	m^2	2,269.8
13	Land TC.VT4 - Nguyen Ai Quoc road (Tan Phong crossroad to 30/4 park)	m^2	2,936.2
14	Agricultural land	m^2	80,738.5
15	Support average 35% land area to location of project.	m^2	80,738.5
16	C3H3 House	m^2	140.0
17	C3H4 House	m^2	160.0
18	C4H2 House	m^2	194.0
19	C4H3 House	m^2	190.0
20	C4H4 House	m^2	320.0
21	Wall	m^2	185.0
22	Eaves	m^2	120.0
23	Cement yard	m^2	270.0
24	Concrete yard	m^2	325.0
25	Pond	m^2	50.0
26	Fish pond	m^2	100.0
27	Galvanometer (main)	unit	25
28	Water meter (main)	unit	25
29	Telephone	unit	25
30	Transportation allowance	unit	25

Note: TC: residential land; VT3: 3^{th} ranked location of plot; C3H2 house: 3^{th} ranked house which is located at 2^{nd} ranked lane.

II.3 Steps to minimize resettlement

There is no denying that the execution of the priority phase of project on sewerage and wastewater treatment system in Bien Hoa City will improve effectively the living standard for resident in Bien Hoa city as well as project area, however, the influence to household is not inconsiderable. Therefore, during the implementation project, it is effortful to follow the basic concepts such as “to avoid from the resettlement of households as much as possible” and “minimize the influence because of resettlement as much as possible.” Hence, during the implementation project, the design selection, the dredging, rehabilitation, and renovation the streams and ditches also affect considerably to the compensation, site clearance, and resettlement. PMU for sewerage projects in company with the consultants researched carefully the Basic Design of project, combining with site surveying and consulting with the affected households, local government. From that point, the design plan was generated to minimize the unforeseen influence acceptably. However, the influence to household is not inconsiderable. In detail, there are 1.065 affected households, the major effect from the construction WWTP at Tam Hiep Ward.

The directed and long term effect to households were determined based on the statistic data from the inventory survey of affected households. In comparison with the huge benefit bringing to Bien Hoa City from the Project, the negative effect causing by project is acceptable.

II.4 Measures to minimize land clearance and resettlement

During the Project preparation, a number of options regarding to designs of springs and wastewater treatment plant have been considered in order to minimize land recovery, resettlement. Options regarding to scales, routes were considered. Priority is considered for streams that cause less impact or insignificant impact for compensation, land clearance and resettlement such as the springs that cross low density populated areas; wild land or agricultural land, public land or run along the current streams. At areas where is high density populated areas, a number of options were considered and adjusted to minimize impacts to affected people. Reduction measures design width, two sides of spring and wastewater treatment plant was carried out and calculated carefully.

Measures to mitigate Project impacts will be considered during the detailed design phase in order to reduce Project cost and resettlement impacts. A number of options will be compared to reduce scale of land clearance and remove affected households. During the construction effective measures, advanced technology as well as management measures will be applied to mitigate negative impact to affected areas and affected households' life.

III. LEGAL FRAMEWORK ON COMPENSATION, RESETTLEMENT SUPPORT

III.1 Law and regulations of Vietnam on compensation and resettlement assistance

- Based on the Law on Land dated in Nov 26,2003;
- Law on Construction No.16/2003/QH11;
- Law on Civil No. 33/2005/QH11;
- Based on Law on complaint and denunciation in 1998, Law on amendment and supplement some items of the Law on complaint and denunciation in 2004, the Law on amending and supplementing some items of the Law of complaint and denunciation in 2005;
- Decree No. 181/2004/ND-CP dated in Oct 29,2004 of Government about implement the Law on Land;
- Decree No. 197/2004/ND-CP dated in Dec 03, 2004 of Government which replaced Decree No. 22/CP stipulate compensation, assistance and resettlement when land is recovered by the State;
- Decree No. 198/2004/ND-CP dated in Dec 03, 2004 of Government about paying compensation and resettle for withdrawing land use.
- Decree No. 17/2006/NĐ-CP in Nov 27, 2006 of Government about amending and supplying some items of decree which guide the conditions for practice Law on land and Decree No. 187/2004/ND-CP about change National company to Joint Stock company;
- Decree No. 84/2007/ND-CP dated in Jan 27,2006 of Government to stipulate *implement* about providing certificate of land use; withdraw of land use, practice to interesting of land user, process, procedure compensation, support, resettle when Nation withdraw and *claim for compensation* about land use;
- Decree No. 69/2009/ND-CP dated in Aug 18, 2009 of Government to stipulate

implement about arrangement of land use, withdrawal, compensation, support and resettle when Nation withdraw land use

- Decree No. 188/2004/ND-CP dated in Nov 16, 2004 and Decree No. 123/2007/ND-CP of Government for specify for land use price methods and issuance of land price framework for land categories;
- Decree No. 123/2007/ND-CP dated in July 27,2007 of Government for amend and supply some items of Decree No. 188/2004/ND-CP dated in November 16, 2004;
- Decree No. 131/2006/ND-CP dated in Nov 09,2006 of Government for issue management regulations and use Official Development Assistance (ODA) source;
- Circular 69/2006/TT-BTC dated in Nov 26,2009 of Ministry of Finance for amend and supply some items of Circular 116/2004/TT-BTC dated in December 07,2004 about to practice Decree No.197/2004/ND-CP;
- Circular 114/2004/TT-BTC dated in Nov 26,2004 of Ministry of Finance for guide the implementation of Decree 188/2004/ND-CP;
- Circular No. 69/2006/TT-BTC amending and supplementing some articles of Circular No. 116/2004/TT-BTC dated 12/07/2004 guiding the implementation of Decree No. 197/2004 / ND-CP;
- Circular Joint No. 14/2008/TTLT/BTC-BTNMT dated in Jan 31,2008 of the Ministry of Finance and Ministry of Natural Resources and Environment to implement some items of Decree No. 84/2007/ND-CP dated in May 25,2007 of Government about providing certificate of land use; withdraw of land use, practice to interesting of land user, process, procedure compensation, support, resettle when State withdraw and *claim for compensation* about land use;
- Circular No. 145/2007/TT-BTC dated Dec 06, 2007 of the Ministry of Finance guiding the implementation of Decree 188/2004/ND-CP dated 11/6/2004 on methods of determining land prices and frame of land prices;
- Circular No. 14/2009/TT-BTNMT dated in Oct 1, 2009 of Ministry of Natural Resources - Environment detailed provisions for compensation, assistance and resettlement, and the order and procedures for land acquisition, land lease.

III.2 Provisions on compensation and resettlement assistance in Dong Nai Province

- *Decision No. 09/2007/QD-UBND, dated in Jan 10, 2007 of DNPPC about issuing regulations of campaign spending to compensation and clearance when the State withdraw land use in Dong Nai province;*
- *Decision No. 12/2008/QD-UBND, dated in Feb 12, 2008 of DNPPC about issuing regulations of medical support services for people eligible for resettlement when the State withdraw land use in Dong Nai province;*
- *Decision No. 26/2008/QD-UBND, dated in April 07, 2008 of DNPPC about issuing regulations of training and applying jobs for the people who was withdrawn land use;*
- *Decision No. 05/2008/QD-UBND, dated in Jan 15, 2008 of DNPPC about issuing regulations of tuition assistance for resettled people's children;*
- *Decision No. 21/2010/QD-UBND, dated in April 05, 2010 about issuing procedures of compensation, support, resettlement and land withdraw, transfer, lease in Dong Nai province;*
- *Decision No. 20/2010/QD-UBND, dated in April 05, 2010 about issuing policies of resettled support, regular and procedures when the State withdraw land use in Dong*

Nai province;

- *Decision No. 30/2008/QD-UBND, dated in April 14, 2008 of DNPPC about issuing regulations of the prices unit of compensation and property the State withdraw land use in Dong Nai province;*
- *Decision No. 72/QD-UBND dated in Oct 30, 2008 of DNPPC about issuing regulations of the prices unit of construction to compensate when the State withdrawn land use, to sell state-owned to the tenant, to assess in a court case, execution and evaluation of the economic profession in the province of Dong Nai;*
- *Decision No. 78/2010/QD-UBND, dated in Dec 21, 2010 of DNPPC about issuing regulations of area, kind, local division which is basic to regulate the price of kind of land use in Dong Nai province in 2011*

IV. SOCIO ECONOMIC CONDITIONS

IV.1 Population

According to statistic in 2010, Bien Hoa city has twenty-three (23) wards and seven (07) communes with 264.08 km² area, population is 784,398 people. The increase population is 1% per year; the population density is 2,970 persons per km². *(Source: Statistical Yearbook of Dong Nai province in 2010)*. Bien Hoa city has only 732 poor households take 0.3% rate (according to a report summarizing the work of poverty reduction for 2006-2010).

Table 6: Population of Bien Hoa City

Wards and communes	Total population	Notes
Thanh Binh	5,188	
Tan Hoa	38,173	
Tan Bien	37,108	
Thong Nhat	22,813	
Hoa Binh	8,320	
Trung Dung	18,051	
Quang Vinh	15,371	
Quyet Thang	15,289	
Buu Long	23,268	
Tan Vạn	13,837	
Tan Phong	41,628	
Tan Tien	15,152	
Trang Dai	51,273	
Tan Mai	20,478	
Tam Hiep	26,658	
Tan Hiep	34,636	
Tam Hoa	16,801	
Binh Đa	17,868	
An Binh	41,260	
Long Binh Tan	39,509	
Long Binh	67,367	
Ho Nai	31,108	

Tan Hạnh	8,474	
Hoa An	24,684	
Hiep Hoa	12,914	
04 new wards (Phuoc Tan, Tam Phuoc, An Hoa, Long Hung**)**	**117,996**	
Total	**784,398**	

Source: Statistical Yearbook of Dong Nai province in 2010

IV.2 Economic condition of Bien Hoa city

Bien Hoa has potential industrial development with soil suit to construct the infrastructure of industrial parks, has many mineral resources particularly the building materials, convenient source of electricity, abundant raw water to supply to the production and domestic activities (Dong Nai River). In addition, potential human resources advance to industrialize-modernize. Bien Hoa City has many attractive tourist spots which has ben exploited such as: Dong Nai river tourist, Ba Xe isle, Tan Van isle, Buu Long tourist, and historical sites of national cultural...

Bien Hoa City is an important industrial centre of the country. Bien Hoa Industrial Zone has industrial zone: Bien Hoa 1, Bien Hoa 2, Amata and Loteco that has been constructed and invested synchronously. Bien Hoa is an important traffic of Dong Nai province. Besides North - South railway system, Bien Hoa has highway system such as No.1, No. 51, and No. 15 Highway.

The economic development process of the Bien Hoa city has always been to maintain stability. GDP growth rate of 5-year average is 14.5% of Bien Hoa. In 2009, because economic slowdown so that the growth rate reduce 10.32%, but in 2010 one was restored promptly with an increase of 14% (estimate). Results depend rightly direction of the leader of the city in economic restructuring: the industrial construction take 64.5%, increasing the proportion of service sector from 28.7% to 35, 1%. Many commercial projects and services have been built and put into operation, such as Co.op Mart, Vinatex, Metro, Cholon electronic market, Phan Khang, Bien Hoa, Sar market, Big C trade centre...not only contribute to improving the living conditions of people, but also to change the face of Bien Hoa City.

V. COMPENSATION POLICY AND SUPPORT

V.1 Principle compensation

Households and individuals have used legal land under provisions of Article 8 Decree No. 197/2004/ND-CP acquired by the State can receive compensation as regulations, for households don't have enough conditions to receive compensation as provisions they can be considered for support by the PC, the land is being used on what kind of purpose shall be compensated by providing new land with the same use purpose, if the land is not available for compensation, the compensation shall be in cash equivalent to value of land use right at the acquired period, and if there are differences in value of new land compensation or new houses, the differences shall be paid in cash.

For housing and works which serve the daily activities of households, individuals to be dismantled completely or affected when the State acquire the land, they can be compensated with equal value for construction of the new house, works with the same technical standard.

All the households who affected their housing, job or business or farming in the acquired area of the project at the time of closing for investigation of the status, are entitled to benefit appropriate measures enough to help them improve or at least sustain their living conditions, income capability and production rates as before the project formed. For affected people who don't have legal right on land, lost property shall be still considered to receive counter support to stabilize the living.

Compensation measures, support include: Provide priority compensation on agricultural land equivalent to land with production capability of acquired land if the land fund is available, and compensate with new construction value of houses, other works and property on the acquired land.

Items of the project shall be handed over the land for the contractor to carry out construction when: Complete compensation, resettlement support for affected people satisfactorily and in accordance with the policy frame in approved land clearance compensation Plan, resettlement support.

Project management work shall ensure the implementation of project under design, scheme, public consultation and perform land clearance compensation Plan, resettlement support effectively and timely.

V.2 Eligibility

For the project, the closing date for investigation to determine the validity of compensation benefits, resettlement support taking into account is the completion date of ***the detailed measurement and survey current status*** of assets on affected land based on the basic design of the project and cadastral records of affected land. If the design of the project requires further extension, more land area or land in other areas then the inventory survey, investigation of losses shall be updated and adjusted the closing date for investigation. For households whose living conditions maybe affected due to acquire temporarily of land during construction shall also receive support and compensation.

V.3 Compensation policy when the State acquire the land.

a. Compensation policy on agricultural land

Households and individuals are currently using agricultural land (including: annual crop land, perennial crop land, production forest land is forest, aquaculture land, salt soil, and other agricultural land) are eligible for compensation in accordance to Article 8 of Decree No. 197/2004/ND-CP shall be compensated by allocation of new land with the same land use purpose with location as close as possible when their land acquired. If the compensated land is smaller or lower quality than acquired land, the affected people shall be compensated in cash which equivalent to the difference of land. In case, the land fund is unavailable for compensation or the affected people select cash for the compensation measures, the affected people shall be compensated in cash with similar value.

Households and individuals are using agricultural land by leasing or contracting from State agencies, the compensation on land can not be done when the State acquire land but the affected people shall receive investment cost for remaining land and as well as the support policy as provisions.

In case, after acquisition of agricultural land, the remaining area is not enough to ensure the economic efficiency, the affected people want to be compensated for the whole area (include the remaining area), they can select compensation equivalent to land with the same scope or in cash for the acquired land in accordance with 100% replacement cost.

Households, individuals use agricultural land but when the State acquires land, it is not eligible for compensation according to Article 8 of Decree No. 197/2004/ND-CP, if the households, individuals themselves directly carry out agriculture production and mainly earn their living on agriculture production shall be considered to support according to policy of PC to stabilize their lives.

b. Compensation policy for residential land

Residential land of each household include land for building houses and other works for daily activities of the family. Households, individuals use legal land under provisions of Article 8 of Decree No. 197/2004/ND-CP, the compensation on residential land and works attached to the land shall be made when the State acquire as follows: Compensate by allocation of new residential land or by resettlement or in cash in accordance with value of land use right at the time of issuance of land acquisition decision.

Land users shall be compensated for the acquired area by allocation of new residential land or by resettlement in locations that the affected people accept with all of property rights as before. Where there is no land fund for compensation or if the person whose land is acquired by the project to select of compensation measures in cash shall be compensated in cash according to land use right value at the time of issuance of land acquisition decisions. The works affected due to land acquisition shall be compensated by replacement costs (not including the utilized material). In the following case, when acquire the residential land, the remaining area is not enough to settle (can not rebuild the house or works), if the affected people by the project want to be compensated for the whole area (include the remaining area), the affected people can select for either land compensation of equivalent size or in cash for acquired land in accordance with 100% replacement cost.

Land users have enough conditions under the provisions for compensation for loss of acquired land (legal land users and legalization), but in the course of the dispute shall be compensated at 100% of replacement value and the compensation payment can be received only when the dispute is resolved.

Land users are not eligible to be compensated (illegal land users) shall be considered to support in cash for each specific case by PC.

c. Compensation policy on property, crops, plants, animals

For graves:

Level of compensation for graves to be relocated shall include all excavation, moving, reburial cost and other reasonable related costs. Compensation payment shall be delivered to each affected household.

The facilities affected by the project:

The households have facilities such as water tanks, electric meter ...which are affected by the project shall be compensated by 100% of replacement cost according to market price.

Compensation for loss of crops and plants

For annual crops and perennial crops to be acquired, compensation shall be paid to people who are farming at market price for crops and/or replacement cost for perennial crops.

Compensation for animals:

For animals (aquaculture) shall be compensated as follows:

For animals, at the time of land acquisition, it is the period to harvest, so it shall not be compensated;

For animals, at the time of land acquisition, it is not the period to harvest, the actual damage for compensation shall be made due to early harvest; in case the movement can be made, the compensation on moving cost and damage due to movement shall be made; compensation rate specified by the PPC in accordance with actual condition.

* For properties not eligible for compensation under the provisions of the State, it shall depend on each specific case that the compensation committee of the city submit to PPC for consideration for support, maximum support is 100% of replacement cost in accordance with market price.

d. Compensation policy on housing and architecture works which damaged

Persons with housings, works, and other affected structures which built on the land eligible for compensation under provisions shall be compensated as follows:

Compensation in cash for the whole affected housing/works by 100% of replacement cost. Compensation amount shall be enough to reconstruct the same works in accordance with market price.

Compensation cost for housing and other structures were calculated according to affected actual area by the project, the unit price for calculation is applied by the form prescribed in Decision No. 30/2008/QD-UBND, not based on using area.

For the case of houses and buildings without permission, illegally, when implementing the project, based on each specific case, the recovered land PPC will decide the policies to support additional supplemented, if necessary, to ensure that all affected people can fully restore the lives, homes and their work under the compensation policy, support of the PPC

Compensation cost calculated under the actual area affected by the unit price stipulated in Decision No. 30/2008/QD-UBND, not based on area of use.

For houses and buildings which have no permission or are illegal, during the Project implementation, based on specific case, DPPC will decide the support policies, if necessary, to ensure that all affected people can fully restore the lives, homes and their work under the compensation policy, support of the PPC.

e. Compensation for temporary impacts during constructed stages

For land and assess on that land of households, community, or State agencies which is affected temporarily due to the contractors' constructions, the contractor shall be responsible for:

Compensation for all property on land affected during construction by replacement price.

Compensation for crops / trees full market value at the time of impact and to compensate for loss of income for the following season during the land occupied during the project construction.

Compensation and support for loss income of household production, cooperatives, private businesses during construction.

Quickly restore the original status quo or improve soil quality better when there is no project.

Construction contractors quickly restore the status quote of public works such as quality loss earlier after completion of construction activities.

f. Compensation for in-directive impacts

This applies to those affected by the taking of land for individual resettlement or resettlement focus. Affected by those two types are also affected as people directly affected by the project, so they are entitled to compensation measures and assistance similar to those directly affected from occupied land.

g. Compensation for public property affected

In the case of public infrastructure such as schools, bridges, factories, water sources, roads, sewage systems damaged, the project must ensure that the infrastructure is restored or repaired; depending under the circumstances and the community is not paying for it.

Project must have to minimize the impacts of land acquisition to cultural works. In cases that affect cultural works, they must take measures to resolve specific cases. For cultural projects, churches, temples, pagodas, am, shrines by local management must be relocated if the MPC decided on the basis of recommendations of the Council of compensation and site clearance consult your local authorities and people in the work areas affected.

V.4 Supporting policies when Sate withdraw land use

Support Policies the land of acquisition project is based on the decrees, circular's current state and decide on 05/4/2010 20/2010/QD-UBND Dong Nai Province People's Committee issued :

Table 7: Rules of level - assistance in the project

Types of support and compensation	Level - assistance according Decision No. 20/2010/QD-UBND on 05/4/2010 of DNPPC which was issued:
Removal support	Providing fund support to households moving individuals when State recover land which must be moved: from 4 million subsidy for those households moving within the city of Bien Hoa, 6 million for households to move out of Bien Hoa city, but within the province, 8 million for the households have moved to other provinces - For organizations that are state land and lease or use of legal land as a place of production, business recovery when state funds are being dismantled, moved and installed for organizations are allocated or leased land or land use lawfully when the State recovers that have moved production facilities, business
Support rent housing while waiting for resettlement	- Support to lease house while waiting for resettlement: the level of support from 1.5 million VND per household per month for those households with less than 6 people, for the six households, each demographic increase 250,000 per month but the amount of support not exceeding 2,500,000 VND/household/month during 05 months for households are allocated land for resettlement, with the households assigned resettlement support time was 01 months - For the affected households in need of repair shall be supported with travel costs and costs by 50% of households support for clearance and support time the rent is 03 Months
Resettlement support for land acquisition cases in	The minimum value of one resettlement rates in Bien Hoa is 300 million.
Support stable life and production by the recovery of agricultural land	Households recovered from 30% to 70% of agricultural land is used, supported by stable life equivalent of 30kg of rice / demographic / month for 6 months with non-mobile households move, for displaced households to support time was 12 months for those moving to areas with economic conditions - social problems or difficulties, the time supported to 24 months; Households and recovered over 70% of agricultural land is used, supported by stable life equivalent of 30 kg of rice / demographic / month in 12 months with non-displaced households in and within 24 months for the households have moved, for those moving to areas with difficult socio - economic conditions are particularly difficult or time to support a maximum of 36 Months

Support for agricultural land in the residential land and garden, pond land are not recognized in the land	Households and individuals whose land is recovered when the gardens and ponds in the same parcel of land with houses in residential areas but not recognized as the residential land gardens, ponds in the same parcel of land with separate houses, land gardens and ponds in the same parcel of land with houses along the canals and ditches and along roads, in addition to be compensated at the price of agricultural land for perennial crops are also supported by 50% of the parcel of land in that land; area Supported area not exceeding 05 times the quota allocation in local - Households and individuals recovered agricultural land in the administrative boundaries of wards or in residential areas of towns and rural areas, agricultural land adjacent to the ward boundaries, neighborhood boundaries residents, in addition to the compensation of agricultural land prices are also supported by 35% in average land price of the land area is withdrawn in accordance with local land price; support area not exceeding 05 time limits in the local land
Support converting career and job creation	Households and individuals directly in agricultural production as land recovered shall be supported switch careers and job creation in the following forms Support in cash equal to 1.5 times the price of agricultural land for the whole area of agricultural land is recovered Support one with a capacity of land or an apartment or land a production capacity of non-agricultural business (forms of support will depend on the land fund and the fund house in the locality) Admit to the vocational training institutions cost-free training courses
Benefit ceased production and business	Households, individuals and organizations are manufacturing business supported the full cost of dismantling, moving and installation. Costs by the unit specific unit prices stipulated by PPC and financial institutions with responsibility for evaluation Backed by 30% per annum of disposable income, average income level of the three years preceding the tax authorities confirmed. Supports 75% of compensation costs in the area of agricultural land revoked for families and individuals who are officials and employees of the farms are working or retired are receiving the contracting agricultural land and direct agricultural production and livelihood mainly from agriculture. For households without business registration package will be supported by one-time money for lost income. Support amount will be determined during preparation of compensation and resettlement
Support of political objects	Households eligible for family policies (Vietnam heroic mothers, war invalids, sick soldiers, martyrs' families) and households under the poverty alleviation, protection of ethnic minorities being recovered state land receive additional support from the following: Support 20,000,000 million VND eligible households with Vietnam heroic mothers, war invalids of 1 / 4, sick soldiers rank third, martyrs' families. Support 15,000,000 million VND to households with eligible injured and sick soldiers have lost their labor rate from 61% - 80% Support 10,000,000 VND to households with eligible injured and sick soldiers have lost their labor rate from 21% - 61% of eligible

	households and poverty, ethnic minority
Cash assistance for families and individuals have land recovery area larger	Support 25% infrastructure rate investment land resettlement focus area for households to recover from 1.000m² 2.000m². Support 50% infrastructure rate investment land resettlement focus to households to recover from 2.000m² to 3000m² areas.
Reward for those in good standing legislation on land acquisition	- Reward 1,000,000 VND to households with compensation amount is under 10 mil. VND - Reward 2,000,000 VND to households with compensation amount is from 10,000,000 to under 20,000,000 VND - Reward 4,000,000 VND to households with compensation amount is 20,000,000 to 50,000,000 VND - Reward 6,000,000 VND to households with compensation amount is from 50,000,000 to under 100,000,000 VND - Reward 8,000,000 VND to households with compensation amount is from 100,000,000 to under 200,000,000 VND - Reward 10,000,000 VND to households with compensation amount is 200,000,000 to under 300,000,000 VND - Reward 12,000,000 to households with compensation amount is more than 300,000,000 VND

VI. RESETTLEMENT POLICY

VI.1 Purpose of resettlement

The objectives of the resettlement policy framework is to ensure that all affected people by projects must be compensated or help support their recovery, improve living standards or at least maintain the conditions life and ability to generate income before the project.

VI.2 Principles of Resettlement

Policy guidelines for resettlement of the project as follows:

Bien Hoa City People's Committee (BHCPC) is responsible for complete construction of infrastructure; housing and resettlement arrangement to ensure the recovery of land must be moved has a new or better than the old place.

Prior to resettlement are in place for land acquisition in projects where resettlement, priority convenient location for the early implementation of household clearance, they are conveniently located at the old place, household policies.

The land recovery and affected properties as well as the relocation of affected people should be reduced as much as possible.

Budget that pays the cost of land recovery, resettlement, and stable life must be completely prepared and available in the implement period of project, and during the implement period agreement. Resources will be available for resettlement and stabilization their lives when required.

VI.3 Resettlement measures

According to the law and regulation of Vietnam and Dong Nai, resettlement measures are as following:

- Resettlement in apartments or relocation plot
- Resettlement in the form of assignment of new land which has equivalent use

purposes.

- Resettlement in form of payment if affected household can arrange accommodation by themselves.

VI.4 Select a location, prepare the location and layout relocation

Select position and prepared the resettlement plan for farmers whose land is compensation to build the No.2 wastewater treatment plant beforehand in 2011. In 18/11/2010 Dong Nai Drainage PMU and Bien Hoa city Urban Management Department (BHUMD) (the unit responsible for the construction of infrastructure, housing and residential relocation service) and local government representatives (Office of Urban Management, Bien Hoa city) worked together. As a result of the meeting, the sides agreed to select four (04) Nguyen Ai Quoc apartment blocks was built at Quang Vinh ward ready to move settle and another resettlement at Buu Long ward with 9 ha area, one at Tan Bien ward with 9.2 ha area expected to complete the infrastructure in 2011.

After preliminary review of the households have to arrange resettlement upon land recovery to build No.2 wastewater treatment plant, No.1 pumping station and the route of a stream of about 140 households. In 30/12/2010, Dong Nai drainage PMU and Bien Hoa PMU (unit responsible for the construction of infrastructure, housing and residential relocation service) and representatives of local authorities (Department of Urban Management, Bien Hoa Natural Resources and Environment Department, centre for Development of Bien Hoa city land worked together, at the meeting the relative parties agreed and select seven (07) resettlements at Buu Long, Tan Mai, Tan Bien, Tan Hoa and Tan Hanh ward to ensure adequately resettlements for all households who will be affected by project (result of the meeting concluded at appendix).

VI.5 Housing, infrastructure and social services

Housing and infrastructure for resettlement: The secondary residential zones and residential areas for resettlement are the city People's Committee of the construction complete, meet the requirements for resettlement households whose land is revoked to ensure better for another place in the old.

Social Services: The residential relocation service located in wards of Bien Hoa city, so the use of social services by households such as schools, hospitals, parks, the general entertainment, etc exist as primary as has no project. Also some new resettlement areas will be invested in schools, parks.

VI.6 Environmental management and protection in resettlement areas

Wastewater collection and management: the resettlement areas are construction and sewer systems and collective wastewater completely.

Domestic and solid waste management: Bien Hoa Urban and Environment Company (BHUE) collects domestic and solid waste every day at the households.

VI.7 Ability to integrate into the community resettlement

The construction of resettlement areas within the city and near the location of the land recovery to create favorable conditions for affected households. These make the important contribution which support the household integrate rapidly with new residential community at new settle.

VII. IMPLEMENTING PROGRESS

VII.1 Schedule of implementing compensation, support and resettlement

Recovered and use notice: When the basic design is completed, land recovery plan is announced to households;

Check - count in detail, investigation, and survey the current situation: When land document which define land recovery areas is finished, check - count in detail will be conducted. These results of survey will be basis to calculate the value of compensation and update the restitution of surface porting plans. The data will be put into the computer by Dong Nai Drainage PMU and Bien Hoa Land Fund Development Centre (LFDC)

Define source, type of land, property, class of building, resident, manufacture conditions; When inventory is finished, confirmation will be conducted. Wards of People's Committee, Department of Urban Management (DUM), Land Use Registration Office (LURO) Bien Hoa city check accuracy of data in detail before Centre of Development Land Fund of Bien Hoa city plan alternate approve;

Update unit price. Dong Nai People's Committee will update unit price of cost compensation which have the same value as damaged properties. This will be done in consultation process between suffered people and functional company;

Apply price and calculate valuable compensation, support to suffered people. Bien Hoa city People's Committee will be responsible for directing Centre of Development Land Fund of Bien Hoa city apply unit price of cost compensation which was issued by Dong Nai People's Committee (the amount of money can be calculated base on real surveys) and do compensation of document for damaged house. Unit rice, affected properties, the valuable compensation, the rights of people, etc will be notice to each affected households and show to verification of jury of Dong Nai province. All the compensation of forms must have check and sign by affected people;

Compensation process must have to supervise by represent of Bien Hoa city and ward of People's Committee and affected people.

VII.2 Progress steps clear the land, compensation and resettlement of the project

Progress steps clear the land; compensation and resettlement of the project are as folloing table:

Activities	Schedule
Schedule for land acquisition of STP 2	
Notification of land for project	Completed
Prepare land survey document of the land to be recovered	Completed
Inventory survey	Completed
Verification of land records; land sources	Mar. 2011
Develop plan on compensation, support and resettlement (plan)	Apr. 2011
Publicly post up, take comments and complete the plan accordingly	May 2011
Submit plan for appraisal and approval	Jun. 2011
Make payment on compensation, support, … for affected persons	Jul. 2011
Hand over recovered land to project owner	Aug. 2011

Spare Time (out of process): Time spare to solve problems which may occur during implementation)	Aug. 2011 - Mar. 2012
Schedule of land acquisition of Pumping Station No. 1 and streams	
Issue notice on land acquisition; publicly post up notice of land acquisition; propose to establish committee on land acquisition, compensation	Mar. 2011
Prepare land surveyed document of the land to be recovered	Apr. – Jul. 2011
Inventory survey	Aug. – Sep. 2011
Verification of land records; land sources	Oct. 2011
Develop plan on compensation, support and resettlement (plan)	Nov. 2011
Publicly post up, take comments and complete the plan accordingly	Dec. 2011
Submit plan for appraisal and approval	Jan. 2012
Make payment on compensation, support, ... for affected persons	Feb. 2012
Hand over recovered land to project owner	Mar. 2012
Spare Time (out of process): Time spare to solve problems which may occur during implementation)	Apr. - Sep. 2012

VIII. INSTITUTIONAL ARRANGEMENT AND RESPONSIBILITIES

The terms and policies of the policy framework compensation and plan of resettlement will be legal basis for implement the compensation, support, resettlement in the project.

Organized structure and mainly responsibility for each involved department show as following:

VIII.1 DNPPC

DNPPC conduct projects directly, responsible for carrying out the whole project, include the implementation of compensation, support and resettlement. UBND is the highest administrative organ that can approve the plan of resettlement and decide on each related resettlement issue, include unit price of compensation and way or support which assist damaged people in the process of project. UBND supply directly all the related department of project.

DNPPC has specific responsibilities:

- To direct, organize, propagate, campaign, and mobilize all organizations and individuals about policies of compensation, assistance of resettlement.
- Direct the departments, BHCPC and the investor, these related units carry out the land use of constructive site.
- Approve plan and alternate of compensation
- Approve/issue the price unit of land, property for compensation calculation and supporting regulations.
- Direct the relevant agencies solve complaints and denunciations by citizens about compensation and assistance of resettlement as regulated law

- Decide or hand over to BHCPC enforcement the cases which didn't keep to decision of land recovery from the State. Direct inspection and handling violations in the area of compensation, assistance, and resettlement.

VIII.2 Department of Finance, Construction, Natural Resources - Environment and departments concerned

Department of Finance studies and issues unit price of compensation, suggest UBND to approve. In the stage of site clearance process, Department of Finance will work closely with the Department of Construction, Department of Natural Resources - Environment, Department of Transportation, Department of Industry and Trade, Bien Hoa City People's Committee consider unit price which applied in the site clearance process. Department of Finance can promote UBND to change unit price so that it is replaced cost at time of payment for compensation to affected people of the project.

Department of Finance (DOF):

Combine with related agencies approve unit price of compensation to UBND

Combine with local agencies to decide the plan of compensation, support and resettlement.

Inspect about pay for compensation, support and cost of implement.

Department of Natural Resources and Environment (DONRE):

+ Guide the define type of land, area, degree, affected rate, land recovery area and conditions of compensation.
+ Combine with Department of Finance approve unit price of compensation to UBND.
+ Combine with related agencies decide boundary of land recovery area.
+ To be the main responsible for considering plan of compensation, support and resettlement.
+ Report plan of compensation, support and resettlement, land recovery of decision to UBND to approve

Department of Construction (DOC):

a. Guide the size, area, and legality of work construction on the land recovery.

b. Evaluate the quality, structures, warehouses, wharves, and other work construction on the land recovery.

c. Check in the worth of houses, buildings on the land recovery to calculate the value of compensation.

d. Combine with relative agencies define location and scale of resettled area.

VIII.3 Dong Nai Drainage PMU

+ Dong Nai Drainage PMU is agency belong to DOC, that represent to responsibilities of DNPPC about activities of project, also include activity of resettlement. PMU consist of the planning - technical department, institutional, human management, finance. The main responsibility of PMU in this project as following:
+ Compose draft of resettlement and show to DNPPC for approval;
+ Make general plan, manage and supervise implement of resettlement process;

+ Combine with LFDC and relative agencies ensure effectively activities of compensation and resettlement comply with initial regulars and aims;
+ Ensure fund of resettlement pay for compensation on time to settle life of affected people;
+ Compose disbursement procedure of resettlement and pay liquidated terms of compensation, prepare period reports and documents which relate to project;
+ Accounting and audit of resettled activities must have to conduct;
+ Update plan of resettlement after detailed design and show it to DNPPC for approval;
+ Conduct the guide of project concludes composed text and distribution of publish information notebook, take comments of community. First duty is contact by letter, form, and related document.
+ Combine with related agencies implement effectively plan of compensation, support and resettlement that approved and fit to regulars, aims of state. This duty conclude assurance of resettled ways and right compensation;
+ Select and supervise consultant and related organ independently.

VIII.4 Bien Hoa City People's Committee (BHCPC)

After plan of compensation, assistance, and resettlement is approved, the BHCPC will be not only responsible for directing and supervising this plan but also solved as follows:

a. BHCPC will be responsible for determining the origin of land and buildings affected

b. To direct, organize, propagate, and mobilize all organizations and individuals on compensation policy, resettlement assistance.

c. City People's Committee responsible for directing the implementation of the compensation the city up and implement the compensation plan.

d. Coordinate with other departments, institutions, and investors for the project.

e. Settle complaints and denunciations about compensation and resettlement assistance.

f. To approve and organize resettlement for households eligible for resettlement

VIII.5 Bien Hoa City Land Fund Development Centre (former Compensation Board)

LFDC of Bien Hoa City's responsibility is assistant of BHCPC implement compensation and resettlement project in Bien Hoa City.

The main responsibility of LFDC of Bien Hoa city include (without limitation) as follows:

a. Plan or perform to release compensation for the preparation of the project assigned by the BHCPC

b. Implement the activities to support compensation, resettlement, and land recovery. Clearing - compensating department define the implementation; check in clearing the space and compensating according to approved plans.

c. Coordinate with the People's Committees of wards, departments, and functional management to the provincial water project implemented good ground clearance.

d. To prepare and implement a plan for compensation, assistance and resettlement arrangement.

e. To be responsible for detailed tally and survey the current situation through compensation forms, preparing compensation charts to submit to PPC for approval and coordination with provincial PMUs to pay damages common for people affected directly or proceed to pay for people affected if assigned;

f. To be responsible for calculating the compensation plans of households and general preparation of compensation amount calculated and submitted to the provincial council to evaluate the appraisal and approval and paying compensation directly to households affected receive compensation fund.

g. To reflect the aspirations and take part in resolving the complaints of those affected by the project on policies and compensation benefits.

h. Work closely with independent monitoring agencies.

i. Find enough land for the relocation of individuals, consideration, and approval of households eligible for resettlement arrangement.

j. Organize the team solve complaint of affected people being by the policies and resettlement benefits.

VIII.6 People's Committees of wards

People's Committee of wards/communes will be responsible for:

a. Coordinate with other functional units of certified land and property. Transfer the feedback of people on the project management and Bien Hoa City compensated council

b. Implement active investigation, survey and mobilize people to implement site clearance work. Contents propaganda purposes including land acquisition, compensation policy, assistance, and resettlement of the project.

c. To appoint the professional staff / civil servants commune to carry out all resettlement activities in the commune that

d. Support for agencies / organizations, including the Provincial Project Management Unit, in disseminating information about the project and to support the community meetings and consultation with affected people;

e. Support for other agencies including the Provincial Project Management Unit, in the opinion surveys, replacement cost survey, a detailed assessment survey, detailed inventory of assets and other activities related to compensation and resettlement;

f. Check and confirm the legal status of land, houses, buildings and property / damage of the affected households and affected organizations;

g. To organize resettlement consideration for the affected households;

h. Ensure that mechanisms for dealing with complaints of affected people is appropriate and correctly specified, documented complaints of affected people, keeping all records of complaints and support from consult affected people related to the rapid settlement of claims.

VIII.7 External supervisor agencies

In depend on evaluation may be conducted by a research organization, university or an organization specializing in social science. This unit will carry out socioeconomic surveys, monitoring and evaluating the implementation of the resettlement plan for the project. The report reviews the progress made, the suitability of the resettlement plan and related proposals should be prepared periodically.

IX. PUBLIC CONSULTATION AND COMPLAINT RESOLUTION MECHANISM

IX.1 Objectives

The dissemination of information to affected people and related agencies is an important part in the preparation and implementation of the project. To consult with affected people and ensure their active participation will reduce the possibility of conflict and minimize the risk of project delays. The objectives of the information program and public consultation are as follows:

To ensure that both local authorities and representatives of affected people are involved in planning and decision making. PMU will closely cooperate with the City authority during the project implementation;

Share all information about proposed project and activities with affected people;

To collect information about the needs and priorities of affected people, as well as information about their reaction to the policy;

Make sure the affected people may offer their recommendations that the project will directly affect their income and living conditions, and whether they will have the opportunity to participate in activities and give their decisions on issues directly affecting them or not;

It is essential to include the cooperation and participation of affected people and publicity in necessary activities for planning and implementing resettlement.

To ensure the transparency in all activities related to land acquisition, resettlement and life stabilizing.

IX.2 Consultations during project preparation

During the project preparation, PMU already cooperated with related local agencies in the affected area to hold public meetings to disseminate information about the project and public consultation, to collect information to assess the impact on project resettlement and offer recommendations on options for the project. This can reduce or eliminate the potential negative impact of residents in the area and ready to deal with issues that may arise during project implementation.

The public meetings on announcing the implementation plan for the project, land acquisition notice were held with the participation of affected households representatives, other related agencies and organizations in the Office People's Committees of wards where the project located.

The concerns of affected people are being recorded in the process of socio-economic survey and public consultation. Those affected people have expressed their support for the project as there is only limited impact. Affected people are mainly interested in:

The compensation cost of land, crops and resettlement policy and other supports such as support on stop of production and business, job change… to stabilize the life of the people in the resettlement area.

IX.3 Community participation

Local governments and relevant organizations, affected people and benefit communities will participate throughout the various phases of planning and implementing the resettlement plan. Affected people will be fully informed the terms of this Policy

Framework at public meetings held by PMU, compensation committee, assistance, resettlement, and local authorities.

Each affected person will be informed and consulted by the People's Committees of communes, wards or municipal People's Committees about their rights and options to restore their lives.

IX.4 Public meetings

Prior to the implementing all items of one project, a meeting with community will be held in turn in each affected commune/ward.

While updating this Resettlement Action Plan, the consultative activities were carried out such as: to disseminate information of project, to disseminate information to community and receive feedback, personal and public meetings. Consultative activities and community involvement will be held continuously during project implementation to ensure all information on project information related to resettlement work be understood properly and accepted by affected communities. The scope of information provided to affected people includes the following contents:

Project description, including the area where the affected people can find Project details;

The impact of the project (eg: during construction) and impacts related to land clearance (if any);

Complaint mechanisms and processes of support requirements, including ensuring policies and procedures of the project are designed to ensure the living conditions of affected people will be re-stabilized as pre-project; information on the responsibility of settling by City Resettlement Council to assist in conflict settlement, dispute or problems on land clearance, compensation unit price, relocation; and information on the procedures that they complained about the paperwork and required for support and solving;

Right to participate and be consulted, including the right of affected people to participate in all aspects of resettlement planning and process of resettlement, especially their desire on resettlement solution for a stable life to affected people to move their housings and moody affected people; and ask the affected people or their representatives to participate in meetings held by PMU in cooperation with relevant agencies on land clearance and resettlement;

Resettlement activities, including an explanation on compensation calculations and compensation payments; and the initial information about the procedures of construction works;

Organization responsibility includes organization method and local authorities participated in the resettlement work, responsibility, their names and positions of government officials and phone number, office location and working hours if any;

Implementation plan, including information about proposed resettlement plan; notice of the date, location and payment procedures of compensation to affected people, to ensure that the construction process just started after completion of all compensated payments adequately.

The following table is a summary of the consultation process during updating the Summary Resettlement Implementation Plan.

Table 8: Consultation process during update of Resettlement Implementation Plan

Activities	Time	Implementation cycle
Disseminate project information: letters and	After closing the list of affected people who	Once

project information book.	entitled to benefits.	
Public meetings held for affected people in wards/communes.	After closing the list of affected people who entitled to benefits. After approval of the compensation unit price.	At least one meeting with affected people or more than one meeting if necessary.

IX.5 Project information book (STTDA)

Project information book is prepared for this project. Main contents of its consist of:

+ Brief description of project;
+ Expected impacts of all kinds;
+ Basic compensation policy and rights of affected people;
+ Consultation and participation of affected people and communities;
+ Dispute settlement;
+ Implementation schedule;
+ Contact person for more detailed information.

The purpose of the project information book is to ensure affected people and beneficiaries understand full details of the program and resettlement plans, compensation and resettlement as well as solutions on resettlement plan applied to the project.

IX.6 Information announcement

In addition to announcement of information to subjects and affected communities, compensation plan, assistance, and resettlement are available at People's Committee of the City and People's Committees of commune for reference.

IX.7 Procedure for complaints resolving

Affected people can give their comments about any aspect of compensation policy, price, land acquisition, resettlement, and entitlements related to the assistance programs to stabilize their lives. Affected people can also express their opinions orally or in written, but if directly speak then the receiving board must record in the first meeting with affected people. Affected people will be free of charge on administrative and legal fee.

The four (4) steps on complaints settling are proposed as follows:

Step 1 – Complaints of affected people on any aspect of the resettlement program, or the damage was not resolved previously must be orally spoken directly or in written at the People's committee of ward/commune. The reflecting contents can be discussed at unofficial meetings with the applicant and Chairman of ward/commune. People's committee of ward/commune will be responsible for solving the problem within 15 days from the date of receiving complaints.

Step 2 - Failure to reach an understanding or appropriate solutions, or if the resettled people do not receive response from the People's committee of ward/commune within 15 days from the data of submission their complaint applications, they can send their complaint applications or present to People's committee of the City. People's committee of the City will issue a decision within one (1) month from the date of receipt of the complaint.

Step 3 - If the affected people do not satisfy with the decision of People's committee of the City or the representative, or not receive any response from the People's committee of the City, they can submit their complaint application to the Provincial People's committee. Provincial People's committee will issue a decision on complaint reply within 30 days from the date of submission of application to Provincial People's committee.

Step 4 - If the affected person still do not satisfy with the decision of the Provincial People's committee or if not receive any response from the Provincial People's committee within the specified time, they can sue to the city court.

X. SUPERVISION AND EVALUATION

X.1 Supervision

Supervision work is a continuous evaluation process of the project implementation in connection with the agreed plan, the use of in/out data, and provision of infrastructures and services from the project. The supervision work provides all concerned parties continuous feedbacks on the implementation, define actual success or potentiality, and identify problems, difficult as soon as possible for timely countermeasures upon project operation. The supervision has two following purposes:

(i) To verify whether project activities are completed efficiently of not, including volume, quantity, quality and progress of works.

(ii) To evaluate whether resettlement work meets the set target and objectives of the project or not, and evaluate degree of achievement of the set target and objectives.

Executing agency (Project Management Unit) and independent supervision unit are to regularly monitor and supervise the implementation of the Compensation, assistance, and Resettlement Plan.

X.2 Internal supervision

Internal supervision of the implementation of Compensation, assistance and Resettlement Plan of the project is under responsibility of the provincial Project Management Unit (PMU). With the assistance of the consultants of the project, executing agencies shall monitor the preparation period and carry out resettlement work through periodic progress reports.

Main items to be supervised periodically:

Payment of compensation amount to all project affected people (PAPs) in accordance with the compensation policy described in plan of compensation, assistance, and resettlement;

Announce project information and consultation procedures to public;

Carry out technical assistance, relocation, payment of allowances and other grants;

Provide support for income restoration and support for rehabilitation program;

Comply with procedures for claims and outstanding issues that require attention on management aspect;

Prioritize affected people towards alternatives provided by the project

Coordination and completion of resettlement activities in awarding of contract for construction of works

PMU will collect monthly information and data from the agencies carrying out compensation, support and resettlement work of the project, the database on information about monitoring and supervising the implementation of the Compensation, Support and Resettlement Plan of the project will be maintained and updated on a monthly basis; monthly reports on implementation status of the Compensation, Support and Resettlement Plan shall be prepared. Supervision reports have the following contents:

+ The number of project affected people by category of impact per project work item, and status of compensation payment and relocation and income restoration for each category;
+ The amount of money allocated for resettlement activities or compensation, and the amount disbursed for each activity;
+ Final results of the settlement of complaints and claims, and outstanding issues

that require the settlement by management agencies of different levels;

+ Problems arising during implementation period
+ Actual progress of resettlement implementation.

X.3 Independent supervision

Objective: The general objective of independent supervision is to periodically provide results of evaluation and independently review the results of implementation of objectives of the Compensation, Support and Resettlement Plan, changes in living standards and employment, income restoration and social services for PAPs; the efficiency, impact and stability of beneficial rights of residents, necessity of additional loss mitigation measures, if any, and to withdraw strategic lessons for future preparation of policies and plans.

Independent supervision unit: as per the request of loan lender, State management agencies on employment of independent supervision consultant, PMU will employ an independent organization to independently supervise and evaluate the implementation of the plan of compensation, assistance, and resettlement. This organization is called independent supervision organization, having professional knowledge in science, society and experience in independent supervision, the organization will start the supervision work once the project is commenced.

Contents of supervision, evaluation of the independent supervision agencies:

Whether the whole compensation amount has been paid to PAPs prior to land acquisition, the value of compensation payment is equivalent to the replacement of affected assets/properties or not.

Support PAPs to rebuild their houses on the remaining land after land acquisition or households who have to relocate and build house in a new area.

Support for income restoration

Carry out public consultation, dissemination, and provision of sufficient information on the compensation, support and resettlement policy of the project to PAPs. Attend public meetings to supervise procedures of public consultation, to record problems arising during public consultation meetings and propose countermeasures. Evaluate public awareness towards the policies and the rights to receive compensation carried out for PAPs.

PAPs will be supervised on the restoration of production activities

Evaluate satisfaction levels of PAPs on the compensation, assistance, and resettlement of the project

Supervise activities and mechanism for settlement of claims by claims settlement agencies

Report on living standards of PAPs during restoration period and potentially outstanding issues in the course of living standard restoration

X.4 Independent supervision:

Survey and case study:

It is necessary to conduct surveys on socioeconomic conditions before the implementation of the Compensation, Support and Resettlement Plan as well as during and after the implementation so as to compare to the success or failure of the Plan. Supervision will be carried out based on case basis. Scope of case study may be 100% households who are subject to relocation and severe affected households, and at least 10% of the remaining households. Survey and case study should be conducted twice a year at minimum.

Survey and case study must be equal to all affected objects including: survey and study on men, women, old people and other sensitive groups

Evaluation survey after resettlement will be carried out after 6 to 12 months after completion of the compensation, support and resettlement work.

Data archives

The independent supervision organization will maintain a database of resettlement supervision information/data. The database contains files of supervision results of supervised households and is updated based on data collected from the following data collection sessions. Executing agencies, management agencies, loan lender and PMU are able to approach all database.

Reports

The independent supervision organization shall submit periodic reports every 6 months and present the findings during supervision period. This supervision report shall be submitted to PMU for review and consideration, then PMU will further submit the report to concerned authorities

The reports to be submitted:

Report on implementation progress of the Compensation, Support and Resettlement Plan,

Report on the deviations, if any, from the terms and principles of the Compensation, Support and Resettlement Plan,

Determine outstanding issues and recommended countermeasures, accordingly executing agencies of the project will be informed of current status and can timely deal with difficulties

Report on difficulties happenings and the issues defined in the previous report

Next supervision report

Supervision report shall be discussed in the meeting between the independent supervision organization and PMU. The meeting is held right after the independent supervision organization unit submitted the report. The following activities will be conducted according to difficulties encountered and the issues defined in the report as well as discussed in meetings between the parties.

X.5 Evaluation:

Evaluation is a consideration at a specified time of impacts of resettlement and the objectives achieved. The independent supervision organization will carry out evaluation of the compensation, support and resettlement period and impacts after 6 to 12 months after completion of all activities of the compensation, support and resettlement work, using the questions/questionnaires and samples which have been used for previous supervision activities.

XI. EXPENDITURES AND BUDGET

XI.1 Capital flow

Fund for resettlement work and implementation of the plan shall be allocated from Dong Nai People's Committee to PMU, and PMU shall be responsible for allocation of the fund for land acquisition and resettlement work to Land Fund Development Center of Bien Hoa City. Land Fund Development Center is responsible for making compensation payment directly to affected households.

XI.2 Price Adjustment according to inflation

Compensation unit price and amount in cash to support for life stability as well as other allowances paid to PAPs will be adjusted on a yearly basis according to the unit prices and support systems issued every year by DNPPC.

XI.3 Compensation price

Land price

Compensation unit prices for various types of land in project area at each affected commune/ward shall be applied to the unit prices for land in Dong Nai province area, promulgated by DNPPC together with the Decision No. 79/2010/QĐ-UBND dated 24/12/2010

Price for assets, trees, crops

Apply unit prices in accordance with the Decision No. 30/2008/QĐ-UBND dated 4/4/2008 by DNPPC promulgated compensation unit prices for trees, assets, associated structures when land is recovered by the State, in Dong Nai province. These unit prices are equivalent to market prices.

XI.4 Foundation for calculation of allowances

The supports listed below are based on the current Decree of Government and the Decision No. 20/2010/QĐ-UBND dated 05/4/2010 of Dong Nai PC promulgating regulations on support policies and standards, procedures for resettlement when land is recovered by the State in Dong Nai province.

XI.5 Determination of compensation amount for losses

After the cadastral map of land lots in project area is approved by competent authority, LFDC of Bien Hoa City will coordinate with relevant authorities to conduct inventory of current status of each household whose land is recovered/acquired in order to exactly define types of assets/properties on the acquired land. All data collected after inventory of current status of each acquired land lot will be calculated for compensation amount based on unit prices and policies promulgated by Dong Nai PC at the time of land recovery.

Total expenditure for land acquisition and clearance as per the Compensation, Support, and Resettlement Plan of the project is estimated at **404,315,750,803 VND, equivalent** to **19,722,720** USD (exchange rate 1 USD = 20,500 VND). The total expenditure amount includes all operation activities and resettlement implementation. Contingency cost is taken as 10%, and is estimated as shown at tables next pages:

TABLE 7: ESTIMATION OF COMPENSATION VALUE FOR WASTEWATER TREATMENT PLANT IN TAM HIEP WARD, BIEN HOA CITY

No.	PROPERTY	UNIT	QUANTITY	UNIT PRICE	RATE %	AMOUNT	REMARKS
1	TC.VT3 land - Pham van thuan Road	M^2	8.063,4	5.000.000	100	40.317.000.000	
2	TC.VT4 land - Pham van thuan Road	M^2	14.525,3	3.600.000	100	52.291.080.000	
3	Agricultural land	M^2	7.047,8	316.000	100	2.227.105.000	
4	Aquatic land	M^2	3.447,9	185.000	100	637.862.000	
5	Support 50% TC.VT4 land- Pham van thuan Road	M^2	7.047,8	3.600.000	50	12.686.040.000	support 50%
	TOTAL LAND COST					**108.159.087.000**	
6	C3H2 house	M^2	80	2.584.000	100	206.720.000	
7	C3H3 house	M^2	140	2.153.000	100	301.420.000	
8	C3H4 house	M^2	40	1.890.000	100	75.600.000	
9	C4H2 house	M^2	890	1.220.000	100	1.085.800.000	
10	C4H3 house	M^2	672	1.005.000	100	675.360.000	
11	C4H4 house	M^2	7.161,5	813.000	100	5.822.299.500	
12	Temporary house	M^2	3.721,0	280.000	100	1.041.880.000	
13	Wall	M^2	1.019,0	180.000	100	183.420.000	
14	Eaves	M^2	172	216.000,0	100	37.152.000	
15	Cement yard	M^2	470	30.000,0	100	14.100.000	
16	Concrete yard		325	60.000,0	100	19.500.000	
17	Pond	unit	84	100.000,0	100	8.400.000	
18	Fish pond	unit	40	250.000,0	100	10.000.000	

19	Pigpen	unit	315	216.000,0	100	68.040.000	
	TOTAL MONEY OF HOUSES AND OTHERS					**9.549.691.500**	
20	Galvanometer (main)	unit	68	800.000	100	54.400.000	
21	Water meter (main)	unit	68	400.000	100	27.200.000	
22	Telephone	unit	68	1.200.000	100	81.600.000	
23	Transportation allowance	unit	70	4.000.000	100	280.000.000	
	TOTAL OTHERS ALLOWANCE					**443.200.000**	
24	Crop plant	tree				40.000.000	
	TOTAL CROP PLANT					**40.000.000**	
	Advance payment for infrastructure development (15%)					17.728.796.775	
	Cost for Compensation Committee 2%					2.718.415.506	
	Contingency					13.863.919.078	
	TOTAL					**152.503.109.859**	

Table 8: COST ESTIMATE FOR COMPENSATION OF LAND ACQUISITION FOR CONSTRUCTION OF PS No. 1 AND STREAMS RENOVATION

No.	PROPERTY	UNIT	QUANTITY	UNIT PRICE	RATE %	AMOUNT	REMARKS
1	TC. VT4 land - Ha Huy Giap Road (from Rach Cat Bridge to Vo Thi Sau Road)	M^2	3.269.5	3.400.000	100	11.116.300.000	
2	TC.VT3 land - Ha Noi Highway (Cau Sap bridge to boundary of Dong Nai province)	M^2	3.215.6	2.900.000	100	9.325.240.000	
3	TC.VT4 land - Ha Noi Highway (Cau Sap bridge to boundary of Dong Nai province)	M^2	2.053.7	2000.000	100	4.107.400.000	
4	TC.VT1 land - Hung Dao Vuong Road(5 Bien Hung Crossroad to Bien Hoa Railway station)	M^2	717.9	11.000.000	100	7.896.900.000	
5	TC.VT3 land - Hung Dao Vuong Road (5 Bien Hung Crossroad to Bien Hoa Railway station)	M^2	2.650.3	3.500.000	100	9.276.050.000	
6	TC.VT1 land - Tran Quoc Toan Road (Vu Hong Pho to end of Tran Quoc Toan Road)	M^2	625.7	8.000.000	100	5.005.600.000	
7	TC.VT2 land - Tran Quoc Toan Road (Vu Hong Pho to end of Tran Quoc Toan Road)	M^2	1.788.4	3.200.000	100		
8	TC.VT4 land - Tran Quoc Toan Road (Vu Hong Pho to end of Tran Quoc Toan Road)	M^2	2.140.4	1.800.000	100	3.852.720.000	
9	TC.VT1 land - Ha Noi Highway (alley side Ha Noi Parish (right) - market side Fourth ward (right) to Sap Bridge	M^2	811.6	13,000,000,000	100	10.550.800.000	
10	TC.VT2 land - Ha Noi Highway (alley side Ha Noi Parish (right) - market side Fourth ward (right) to Sap Bridge	M^2	2,617.3	3,400,000	100	8,898,820.000	
11	TC.VT4land - Ha Noi Highway (alley side Ha Noi Parish (right) - market side Fourth ward (right) to Sap Bridge	M^2	1,519.2	3,000,000	100	4,557,600,000	
12	Land TC.VT1- Nguyen Ai Quoc road (Tan Phong crossroad to 30/4 park)	M^2	2,269.8	10,000,000	100	22,698,000,000	
13	Land TC.VT4 - Nguyen Ai Quoc road (Tan Phong crossroad to 30/4 park)	M^2	2,936.2	2,300,000	100	6,753,260,000	

14	Agricultural land	M^2	80,738.5	316,000	100	25,513,366,000	
15	Support average 35% land area to location of project.	M^2	80,738.5	2,061,500	35	58,254,846,000	Support 35%
	TOTAL OF LAND COST					**193,529,782,000**	
16	C3H3 House	M^2	140.0	2,153,000	100	301,420,000	
17	C3H4 House	M^2	160.0	1,890,000	100	302,400,000	
18	C4H2 House	M^2	194.0	1,220,000	100	236,680,000	
19	C4H3 House	M^2	190.0	1,005,000	100	190,950,000	
20	C4H4 House	M^2	320.0	813,000	100	260,160,000	
21	Wall	M^2	185.0	180,000	100	33,300,000	
22	Eaves	M^2	120.0	216,000.0	100	25,920,000	
23	Cement yard	M^2	270.0	30,000.0	100	8,100,000	
24	Concrete yard	M^2	325.0	60,000.0	100	19,500,000	
25	Pond	M^2	50.0	100,000.0	100	5,000,000	
26	Fish pond	M^2	100.0	250,000.0	100	25,000,000	
	TOTAL (HOUSES AND WORKS)					**1,408,430,000**	
27	Electricity meter (main)	unit	25	800,000	100	20,000,000	
28	Water meter (main)	unit	25	400,000	100	10,000,000	
29	Telephone	unit	25	1,200,000	100	30,000,000	
30	Transportation allowance	unit	25	4,000,000	100	100,000,000	
	TOTAL (OTHERS ALLOWANCE)					160,000,000	
31	Crops land	tree				60,000,000	
	TOTAL CROP PLANT					60,000,000	
32	Advance payment for infrastructure development (15%)					29,273,731,800	
33	Cost for compensation committee (2%)					4,488,638,876	
34	Contingency					22,892,058,268	
	TOTAL					**251,812,640,944**	

Note: TC: residential land; VT3: 3th ranked location of plot; C3H2 house: 3th ranked house which is located at 2nd ranked lane.

APPENDIX

Minutes of Meeting on the Implementation of Wastewater Treatment and Drainage Projects Phase I

1-1 Wastewater Treatment Plant 1 **1-2 San Mau stream**			
Ward	Ho Nai Ward		
Date	31 December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr. Dong Chi Khoi	Specialist
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of Ho Nai Ward	Mr. Pham Thien Ninh	Chairman
	Site Clearance and Compensation Board of Bien Hoa City	Mr. Vu Ngoc Trong	Specialist
	Household		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase I to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2015 - Location of drainage: Wastewater Treatment Plant 1 and San Mau stream. - Project Area: Quarter 9, 10. - Scope of Works: area of WWTP is 94,021.3 m^2 .		
Comments from local authority	- Currently, there are no documents about land acquisition.		
Comments from Household	- How is the compensation policy and plan? Has it been decided yet? - In case of a land plot divided for some households, how is the compensation implemented? How and what is the procedure?		

Wastewater Treatment Plant No. 2			
Ward	Tam Hiep Ward		
Date	03 December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr.…….	…….
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	Dong Nai Management Unit for Sewerage Projects (PMU):	Ms. Hoang Thi Nhan	Engineer
	PC of Tam Hiep Ward	Ms. Tiet Thi Loan	Chairperson
	Site Clearance and Compensation Board of Bien Hoa City	Mr. Vu Ngoc Trong	Specialist
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase 1 to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2015 - Project: Wastewater Treatment Plant No. 2. - Area of WWTP: 85,831.8 m² .		
Comments from local authority	- – PMU is requested to carry out the land acquisition, resettlement work in a continuous manner in order not to cause worries among the public.		
Comments from Household	- How many stages/phases of the project will be implemented in 2010 – 2015? - What authority is reponsible for land clearance and compensation issues? - During the implementation of the project, if the houses need repairing, what will you do for the houses? - Where is the resettlement area? - How to deal with the households whose some square meters of land remain? Do you acquire the remained land or not? - PMU is requested to announce the area of land acquisition required for construction of WWTP 2 to the public, how many houses will be removed and where will the resettlement area be? Has the land acquisition been carried out or not? What is the compensation price for land acquisition? -		

3 Rach Lung stream project			
Ward	Buu Long Ward		
Date	24th November, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Ms. Le Quyen	Specialist
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	PMU of Dong Nai province	Ms. Tran Thi Hong Hieu	Chief of General Department
		Mr. Pham Van Tai	Engineer
	PC of Buu Long ward	Ms. Le Thi Thu Tam	Deputy Chairperson
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase 1 to organizations, streets locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help PMU of Dong Nai province finish the task. - Pursuant to the policy No. 4706/CN-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on giving the task of a contractor to the PMU of Dong Nai province. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of phase 1: 2010 – 2015 - Rach Lung stream project: crosses through 2 quarters + Quarter 1: section from Dong Nai river to Residential Group 6 of Quarter 1. Residential Groups 1, 3, 6 of Quarter 1 Residential Groups 7, 9 of Quarter 2. - Length of Rach Lung stream route is 1,570m, width of the stream is about 4m, depth is from 2m to 2.5m, slope m = 1. - The sewerage PMU is requested to revise the length of Rach Lung stream route, take off the overlapped sections with other projects. - The detail implementation such as land acquisition, compensation etc. will be carried out in future. - Pumping Station: Residential group 12 of Quarter 2 Residential group 24 of Quarter 4.		
Comments from local authority	None		

4 Drainage system at Bien Hong stream			
Ward	**Trung Dung Ward**		
Date	05 January, 2010		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr:.........	:.........
	Economic department of Bien Hoa city	Mr:.........................	....
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hien	Chief of General Department
	PC of Trung Dung Ward	Ms. Nguyen Ngoc Anh	Chairperson
	Site Clearance and Compensation Board of Bien Hoa City	Mr. Vu Ngoc Trung	Specialist
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase I to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2015 - Drainage system at Dien Hong stream: the starting point is at Nhu Hue Bakery and the ending point is at Hung Dao Vuong street, length is about 330m, construct RC box culvert of cross section 4x 2m. - Project area: Quarter 2 of Trung Dung Ward		
Comments from local authority	- PMU is requested to inform the residents of about the details of the project. - It is necessary to revise the road construction planning on the box culvert.		
Comments from Household	- How is the compensation rate determined? What is the rate of compensation?		

5 Dien Hong stream project			
Ward	Quyet Thang ward		
Date	7th January, 2010		
Participant	Organization	Name	Position
Participants	Urban management department of Bien Hoa city	Mr: Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr: ……………….	………….
	Economic department of Bien Hoa city		………….
	PMU of Dong Nai province	Ms: Tran Thi Hong Hieu	Chief of General Department
	The PC of Quyet Thang ward	Mr: Pham Thanh Long	Deputy Chairperson
	Compensation council of Bien Hoa city	Ms: Bui Thi Huong	Official
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage project phase 1 to organizations, streets locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help PMU of Dong Nai province finish the task. - Pursuant to the policy No. 4706/CN-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on giving the task of a contractor to the PMU of Dong Nai province. - Pursuant to the Decision No. 1197 of Dong Nai province on the approval of the wastewater treatment and drainage project in Bien Hoa city. - Implementation duration of phase 1: 2010 – 2015 - Dien Hong stream project - The project location: Quarter 1 – Quyet Thang ward - Size of cross section: box culvert - 1.5 x 1.5 x 2, sidewalk: 6m, total cross section 9m.		
Comments from local authority	- Citizens must connect to the wastewater sewer by themselves. - About 8 households are affected by the project		
Comments from Household	- When the existing channel is expended, the land clearance will not be influenced. - Citizens will agree to move to another place so that the implementation of drainage can be done. But more discussions are necessary in the future. - Drainage in the Quarter 2 needs updating more information, it is recommended that the PMU of Dong Nai province works with Quyet Thang ward PC about this issue.		

6 Dien Hong stream project			
Ward	**Thong Nhat ward**		
Date	7th January, 2010		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr: Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr:Truong	Specialist
	Economic department of Bien Hoa city	Mr: Cao Hung Huynh	Specialist
	PMU of Dong Nai province	Ms: Tran Thi Hong Hieu	Chief of General Department
		Ms Hoang Thi Nhan	Engineer
	PC of Thong Nhat ward:	Ms: Luong Hong Loan	Deputy Chairperson
		Mr Nguyen Thanh Ngoc	Cadastral Official
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase 1 to organizations, streets locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help PMU of Dong Nai province finish the task. - Pursuant to the policy No. 4706/CN-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on giving the task of a contractor to the PMU of Dong Nai province. - Pursuant to the Decision No. 1197 of Dong Nai province on the approval of the wastewater treatment and drainage project in Bien Hoa city. - Implementation duration of phase 1: 2010 – 2015 - Dien Hong stream project - + The street A11 - Ray street was constructed by D2D company - + The street A11 – Cai river is improved following the project of the PMU - The project location: the Quarter 4 and the Quarter 7 - Houses will not be cleared/moved		
Comments from local authority	- The project must ensure the capacity of drainage and diminish flooding. - During the implementation of the project, the implementation process and itinerary must be ensured in order to avoid affecting on the citizens' life. - Coincident projects must be isolated/separated (the projects which are the implemented in the same with the drainage project must be separated).		
Comments from Household	- It is recommended that the PMU of Dong Nai province provides a more updated information of the drainage project of D2D company to the PMU's drainage project.		

7 San Mau stream			
Ward	**Tan Bien Ward**		
Date	24th December, 2009		
Participants	Organization	Name	Position
Participants	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr.:	....
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of Tan Bien Ward	Mr. Nguyen Quoc Quan	Chairman
	Site Clearance and Compensation Board of Bien Hoa City:	Mr. Vu Ngoc Trung	Specialist
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase I to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2015 - Location for drainage: San Mau stream. - Project Area: Quarter 10, 8B, 8A, 7, 2. - Scope of Works: dredging and constructing rock dike along 2 upstream sides of San Mau stream, the width of stream bottom of 5 – 7.5m, height of 1.8 -2.2m, slope m=1.		
Comments from local authority	- The decision on land acquisition has not been issued yet.		
Comments from Household	- The land area near the stream is very small so where the resettlement area will locate/be arranged? - The distance from the edge of the stream to the pavement should be defined. - How will the affected households be resettled? - The current cross section of the stream bed is small, why is the design cross section so large? (40m)		

8 San Mau stream (from Xom Mai bridge upward)			
Ward	**Trang Dai Ward**		
Date	17th December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr. Tran Thanh Canh	Specialist
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of Trang Dai Ward	Mr. Lam Tan Khai	Chairman
		Mr. Duong Van Quan	Cadastral Official
	Site Clearance and Compensation Board of Bien Hoa City	Mr. Vu Ngoc Trung	Official
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase 1 to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2015. - Project: San Mau stream (from Xom Mai bridge upward). - Project Area: Quarter 4, 5. - Scope of Works: dredging and constructing rock dike along both sides of San Mau stream, the width of stream bottom of 5 – 7.5m, height of 1.8 -2.2m, slope m=1, length: 6,225m.		
Comments from local authority			
Comments from Household	- Why are not the branches that connect to San Mau stream implemented (planned)? - The project is expected to be implemented in 2010, however, the implementation policy has just been announced now (in the end of 2009), how can the land acquisition, compensation and site clearance be finished before the expected project implementation? - The drainage system project will be implemented in Trang Dai Ward. Why is the resettlement work not carried out in Trang Dai Ward.		

<table>
<tr><td colspan="4">9 Linh stream branch</td></tr>
<tr><td>Ward</td><td colspan="3">Tam Hoa Ward</td></tr>
<tr><td>Date</td><td colspan="3">08th December, 2009</td></tr>
<tr><td rowspan="10">Participants</td><td>Organization</td><td>Name</td><td>Position</td></tr>
<tr><td>Urban management department of Bien Hoa city</td><td>Mr. Vo Thanh Le Phuong</td><td>Specialist</td></tr>
<tr><td>Natural resources and environment department of Bien Hoa city</td><td>Mr………..</td><td>:………</td></tr>
<tr><td>Economic department of Bien Hoa city:</td><td>Mr: ………..</td><td>………</td></tr>
<tr><td>PMU of Dong Nai province</td><td>Ms. Tran Thi Hong Hieu</td><td>Chief of General Department</td></tr>
<tr><td></td><td>Ms. Huynh Thi Doan Trinh</td><td>Staff of General Department</td></tr>
<tr><td>PC of Tam Hoa Ward</td><td>Mr. Vu Duc Hanh</td><td>Chairman</td></tr>
<tr><td></td><td>Mr. Pham Minh Hung</td><td>Cadastral Official</td></tr>
<tr><td>Compensation Board of Bien Hoa City:</td><td>Mr. Vu Ngoc Trong</td><td>Specialist</td></tr>
<tr><td>Households</td><td></td><td></td></tr>
<tr><td>Contents</td><td colspan="3">- Inform the implementation policy of wastewater treatment and drainage projects phase 1 to organizations, streets locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help PMU of Dong Nai province finish the task.
- Pursuant to the policy No. 4706/CN-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on giving the task of a contractor to the PMU of Dong Nai province.
- Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I.
- Implementation duration of phase 1: 2010 – 2015
- Location of drainage system: Linh stream branch.
- Location: Quarter 1, 2, 3 of Tam Hoa Ward.</td></tr>
<tr><td>Comments from local authority</td><td colspan="3">- To carry out the Linh stream branch project with the length of 2,260m, width of stream bottom of 3m, slope of m = 1, embankment height: 2m.
- Agricultural land which has been transferred to housing land shall be compensated as same as housing land.
- The bridges crossing residential area will be reconstructed when the stream project is carried out.
- Section from the General Hospital downward will not be carried out as it will break the traffic/transport master plan.</td></tr>
<tr><td>Comments from Household</td><td colspan="3"></td></tr>
</table>

10 Linh stream branch (from behind Dong Nai bus station to the intersection point with Linh stream)			
Ward	Binh Da Ward		
Date	10th December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr.:……………	……
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of Binh Da Ward:	Mr. Pham Canh To	Chairman
	Site Clearance and Compensation Board of Bien Hoa City	Mr. Vu Ngoc Trong	Specialist
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase I to organizations, streets locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help PMU of Dong Nai province finish the task. - Pursuant to the policy No. 4706/CN-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on giving the task of a contractor to the PMU of Dong Nai province. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2020 - Location of drainage system: Linh stream branch (from behind Dong Nai bus station to the intersection point with Linh stream). - Project Area: Quarter 2, 3 of Binh Da Ward.		
Comments from local authority	- Cross section of Linh stream: bottom: 3m, surface: 27m.		
Comments from Household	- It is recommended to consider the connection section from Hanoi Highway to the end of the boundary of Dong Nai bus station. - It should be noted that the foundation of Hung Vuong Temple need to be revised. - It is recommended that the PMU provides for the local people 4 A0 copies.		

II Ong Gia stream			
Ward	**An Binh Ward**		
Date	17th December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr.…………	…………
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of An Binh Ward	Mr. Nguyen Thi Bang	Vice Chairman
		Mr. Le Van Manh	Cadastral Official
	Site Clearance and Compensation Board of Bien Hoa City	Mr. Vu Ngoc Trung	Specialist
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase I to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase I: 2010 – 2015 - Location: Ong Gia stream; length: 2,080 m. - Project Area: Quarter 2, 12, 3 of An Binh Ward. - Scope of Works: renovation of stream and construction of rock dikes along both sides of stream, the width of stream bottom: 4 – 10m, height: 2.5 -3.5m, slope m=1.		
Comments from local authority			
Comments from Household	- Presently the stream area is being occupied significantly by local residents, thus the local authority also expects that the project will be carried out soon. - In Quarter 3, the stream area is occupied by the local residents for installing private sewers. It is required to return the original status when the project will be implemented. - It is recommended that the project should be carried out as soon as possible and announced to local people. - PMU is requested to update the section design where dike was already constructed.		

12-1 Tan Mai stream 12-2 Ba Bot stream			
Ward	Tan Mai Ward		
Date	01st December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr:……	…………
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of Tan Mai Ward	Ms. Hoang Thi Nhan	Engineer
		Mr. Nguyen Thanh Ky	Chairman
		Mr. Vu Van Quy	Cadastral Official
	Site Clearance and Compensation Board of Bien Hoa City:	Mr. Vu Ngoc Trong	Official
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase I to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2015 - The streams for drainage in Tan Mai ward are Tan Mai stream and Ba Bot stream. - - Project Area: Quarter 2, 1, 5, 6, 3 of Tan Mai Ward.		
Comments from local authority	- The streams will only be renovated or will be expanded (30m)? - The implementation schedules: +Phase I : 2010 – 2015 +Phase II: 2015 - 2020.		
Comments from Household	- Wastewater and drainage system in residential area will be constructed under financing or private capital of local residents? - PMU is requested to update the drainage projects which have been carried out to evaluate the appropriateness of the project.		

13 Quarter 11, 4 of Tan Hoa Ward			
Ward	**Tan Hoa Ward**		
Date	29th December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr.:............	Specialist
	Economic department of Bien Hoa city	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of Tan Hoa Ward	Mr. Nguyen Trung Chinh	Chairman
		Mr. Quach Thien Phong	Cadastral Official
		Mr. Tran Quang Minh	Vice Chairman
	Site Clearance and Compensation Board of Bien Hoa City:	Mr. Vu Ngoc Trong	Official
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase 1 to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I. - Implementation duration of Phase 1: 2010 – 2015 - Project Area: Quarter 11, 4 of Tan Hoa Ward.		
Comments from local authority	- Length of the route is over 700m, width is 40m from the center of the existing stream towards its both sides;		
Comments from Household	- According to the red book, the width is only 11m, but the design width is 20m. Please explain. - How is the secondary branches connected to the main stream? - How many times are clearance and compensation executed? - What is the compensation policy? Is the compensation price satisfactory? - If the length of an affected house is 75m, but only 20m will be acquired, how do you treat the remaining 55m? - What is the compensation policy for the land without legal papers? - An affected house is 21m long, but the acquired length is 20m, what is the solution? - 20m is acquired for the implementation of the drainage project so when will the remaining 50m for the gardening project be implemented?		

14 Tan Hiep Ward			
Ward	**Tan Hiep Ward**		
Date	22 December, 2009		
Participants	Organization	Name	Position
	Urban management department of Bien Hoa city:	Mr. Vo Thanh Le Phuong	Specialist
	Natural resources and environment department of Bien Hoa city	Mr.………	…….
	Economic department of Bien Hoa city:	Mr. Cao Hung Huynh	Specialist
	Dong Nai Management Unit for Sewerage Projects (PMU)	Ms. Tran Thi Hong Hieu	Chief of General Department
	PC of Tan Hiep Ward	Mr. Luong Minh Tri	Vice Chairman
	Site Clearance and Compensation Board of Bien Hoa City	Mr. Tran Quoc Duong	Cadastral Official
		Mr. Vu Ngoc Trong	Specialist
	Households		
Contents	- Inform the implementation policy of wastewater treatment and drainage projects phase I to organizations, quarters locating in the area of stream improvement and the area of 2 wastewater treatment plants and also help Dong Nai Management Unit for Sewerage Projects finish the task. - Pursuant to the policy No. 4706/CV-UBT on 27th August, 2004 of the People's Committee of Dong Nai province on assignment of the role of Employer/Investor to Dong Nai Management Unit for Sewerage Projects. - Pursuant to the Decision No. 1197/QD-UBND on 14th April, 2008 of Dong Nai province on the approval of the wastewater treatment & drainage project in Bien Hoa city, Phase I.		
Comments from local authority	No description		

Appendix 13-A

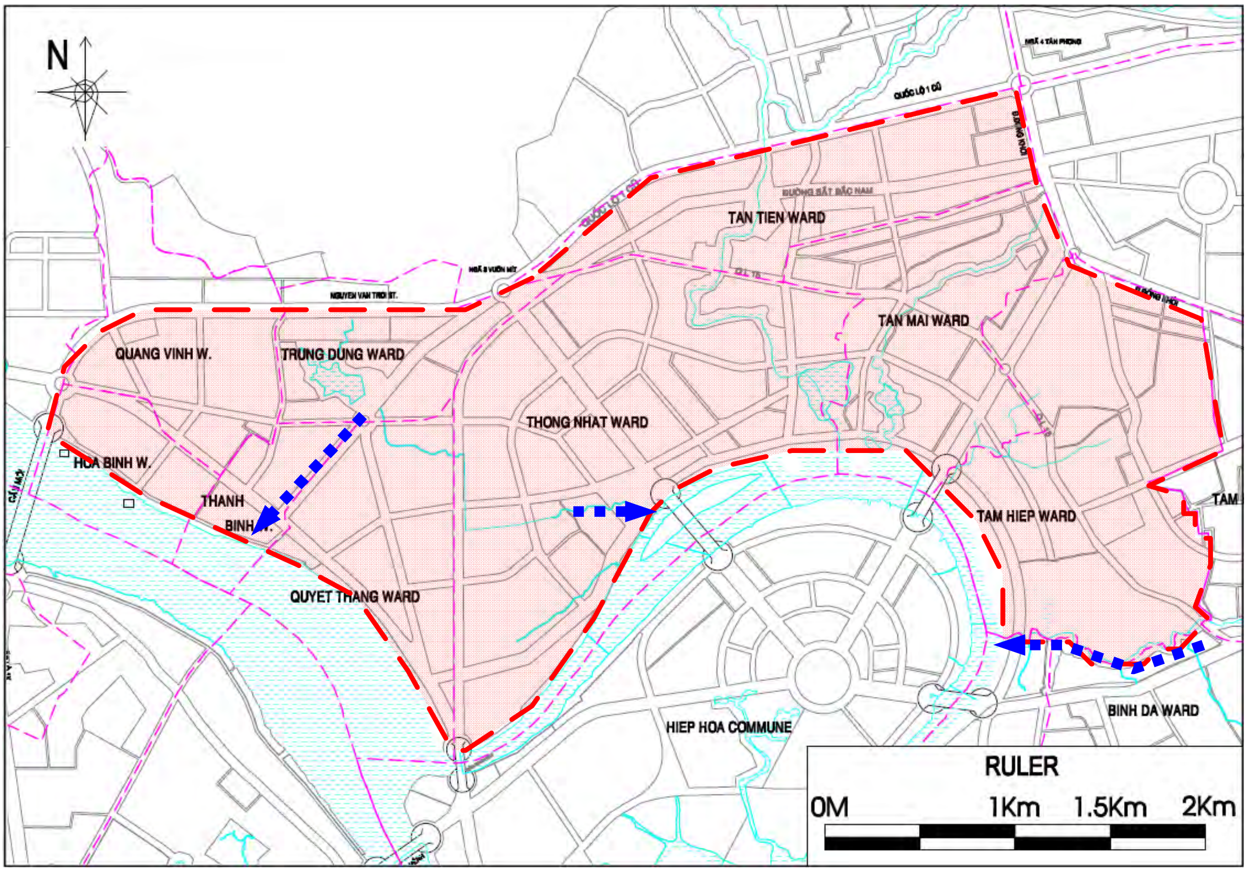
Alternatives of Scope of Works

Appendix 13-A Alternatives of Scope of Works

1. Alternative 1

1.1 Service Area

Service area is the same as original plan.



1.2 Scope of Work

Following components are excluded from the original plan as indicated in the Table 13-A-1

- **Canals except Bien Hung ditch diversion with gate, Dien Hong ditch and Ling stream**
- **Separate sewers and MPs related to planned roads**

Table 13-A-1 Project Components of Alterative 1

Components	Unit	Quantity	Remarks
STP2	m^3/d	52,000 (41,500)	Tam Hiep Ward (Breakdown of sewage flow is presented in Table 13-A-2.)
Pumping Station	places	2	Thong Nhat Ward, STP2 Site
Manhole Type Pump Station	places	18	
Sewerage Facilities			
Main Trunk Sewer	km	10.4	D 200mm – 1500 mm
Branch Sewer	km	40.4	D 200mm – 280 mm
Tertiary Sewer	km	135.1	D 200mm
Interceptor pipe	km	6.3	D 100mm – 900 mm
Drainage Facilities			
Main Storm Sewer for Separate Area	km	32.3	D 600mm – 2000 mm, B 3000mm x H 3000mm
Main Storm Sewer for Combined Area	km	10.3	D 600mm – 2000 mm, B 2000mm x H 2000mm
Brunch Storm Sewer	km	76.8	D 500mm
Canal Improvement			
2.1 Bien Hung ditch with Gate	m	2,160	
3.2 Dien Hong ditch	m	320	
4.1 San Mau stream	m	0	
4.2 San Mau stream	m	0	
4.3 San Mau stream	m	0	
4.4 San Mau stream	m	0	
4.5 San Mau stream	m	0	
4.6 San Mau stream	m	0	
5.1 Linh Bayou	m	0	
6.1 Linh Bayou	m	0	
Linh Stream	m	1,150	
Procurement of O&M equipment	LS	1	High-Velocity Jet Truck, Vacuum Truck etc.

D: Diameter, B: Width, H: Height

Table 13-A-2 Breakdown of Sewage Flow for Alternative 1

Items	unit/ratio	Sub-area			Total	Remarks
		1.1	2 Area without North Area	2 North Area (Out of Pham Van Thuan Street)		
Population	persons	63,269	70,815	54,185	188,269	
Water Consumption	m^3/cap/day	165	165	165		
Sewage Ratio	80%	80%	80%	80%		
House Connection Ratio	100%	100%	100%	100%		
Domestic Sewage Flow	m^3/day	8,352	9,348	7,152	24,852	(1)×(2)×(3)
Infiltration Ratio	10%		935	715	1,650	(4)×(5)
Public Service Ratio	10%	835	935	715	2,485	(4)×(6)
Small Industry	10%	835	935	715	2,485	(4)×(7)
Total	m^3/day	10,022	12,153	9,297	31,472	(4)+(5)+(6)+(7)
Round Population	Persons	63,000	71,000	54,000	188,000	
Round Daily Average Flow	m^3/day	10,000	12,200	9,300	31,500	
Design Flow for STP2	**m^3/day**	**20,000**	**12,200**	**9,300**	**41,500**	

Project Costs

Table 13-A-3 Project Costs of Alterative 1

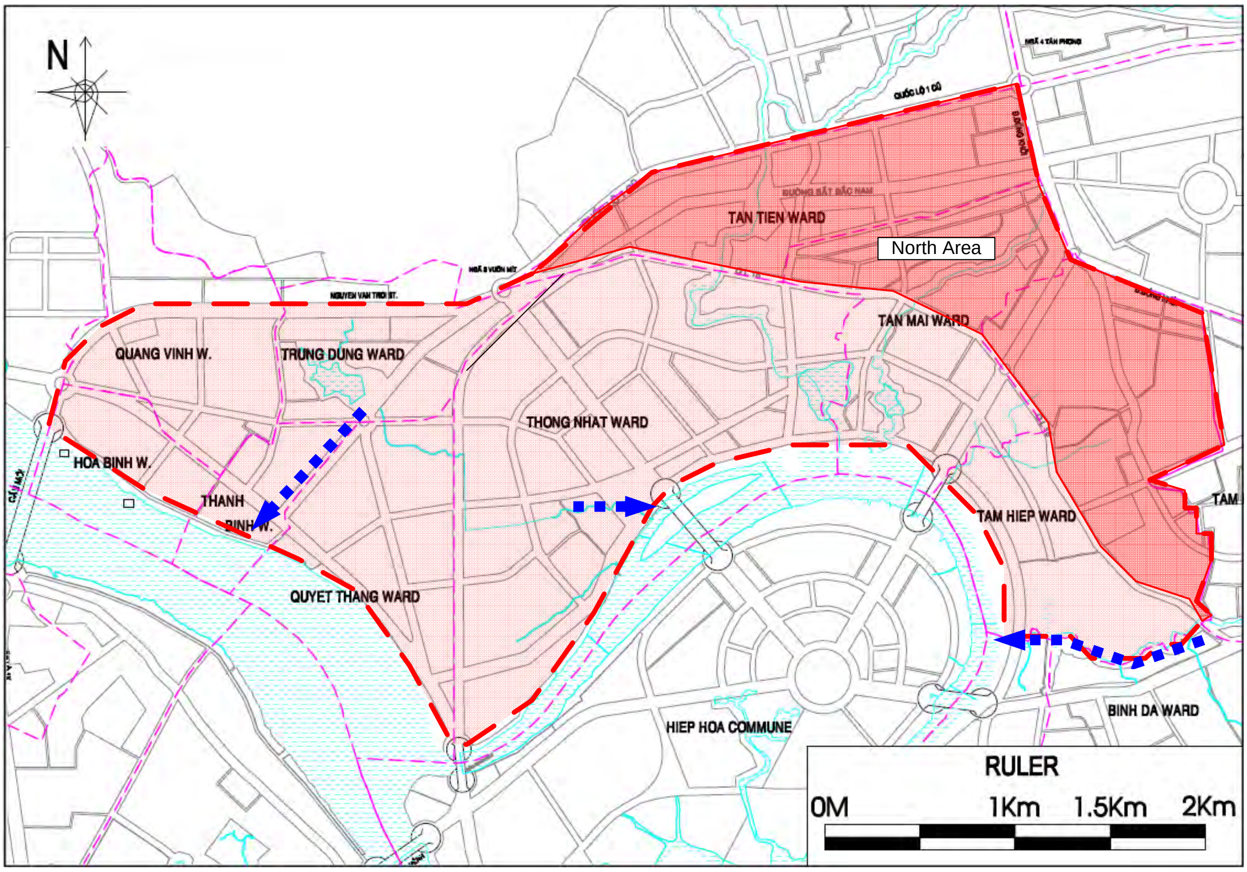
US $	= yen	82.6
US $	= VND	18,945
VND	= yen	0.00436

Description		Foreign	Local	Total	Total
		Million yen	Million VND	Million yen	Million US$
A	**Construction Contracts**				
A.1	PACKAGE Groups: Site Work for STP2	0	28,178	123	1.5
A.2	Facilities	10,073	2,410,732	20,584	249.2
A.3	PACKAGE Groups: Canal Improvement	0	0	0	0.0
A.4	PACKAGE Groups: Maintenance Equipment	0	167,078	728	8.8
	Sub-total	10,073	2,605,988	21,435	259.5
B	**Contingencies**				
B.1	Physical Contingency	562	231,061	1,570	19.0
B.2	Price Contingency on Construction Works	1,172	2,015,232	9,959	120.6
	Sub-total	1,735	2,246,293	11,528	139.6
C	**Engineering Services**				
C.1	D/D, CB, IEC campaign SV and Survey Works	1,440	253,987	2,547	30.8
C.2	Physical Contingency	78	19,530	163	2.0
C.3	Price Contingency on Engineering Services	117	136,610	712	8.6
	Sub-total	1,634	410,127	3,422	41.4
	Total (A+B+C)	13,442	5,262,408	36,386	440.5
D	**Interest During Construction**	1,240	0	1,240	15.0
	Eligible Potion	14,682	5,262,408	37,626	455.5
E	**Cost for Land Acquisition and Supporting Resettlement**				
E.1	Base Cost	0	354,316	1,545	18.7
E.2	Physical Contingency	0	121,772	531	6.4
E.3	Price Contingency on Construction Works	0	51,591	225	2.7
	Sub-total	0	527,679	2,301	27.9
F	**Administration Cost**	0	250,362	1,092	13.2
G	**Vat**				
G.1	Vat (1) for Construction	0	485,228	2,116	25.6
G.2	Vat (2) for Engineering Services	0	41,013	179	2.2
	Sub-total	0	526,241	2,294	27.8
H	**Import tax**	0	308,299	1,344	16.3
	Non Eligible Potion	0	1,612,581	7,031	85.1
Total Project Cost		14,682	6,874,989	44,657	540.6

2. Alternative 2

2.1 Service Area

North Area is excluded from the original plan.



2.2 Scope of Work

Following components are excluded from the original plan as indicated in the Table 13-A-3

- **Canals except Bien Hung ditch diversion with gate, Dien Hong ditch and Ling stream**
- **Separate sewers related to planned roads**
- **Separate sewers and MPs in North Area**

Table 13-A-4 Project Components of Alterative 2

Components	Unit	Quantity	Remarks
STP2	m^3/d	39,000 (32,200)	Tam Hiep Ward (Breakdown of sewage flow is presented in Table 13-A-5.)
Pumping Station	places	2	Thong Nhat Ward, STP2 Site
Manhole Type Pump Station	places	12	
Sewerage Facilities			
Main Trunk Sewer	km	7.5	D 200mm – 1500 mm
Branch Sewer	km	0	D 200mm – 280 mm
Tertiary Sewer	km	48.7	D 200mm
Interceptor pipe	km	6.3	D 100mm – 900 mm
Drainage Facilities			
Main Storm Sewer for Separate Area	km	6.9	D 600mm – 2000 mm, B 3000mm x H 3000mm
Main Storm Sewer for Combined Area	km	10.3	D 600mm – 2000 mm, B 2000mm x H 2000mm
Brunch Storm Sewer	km	57.2	D 500mm
Canal Improvement			
2.1 Bien Hung ditch with Gate	m	2,160	
3.2 Dien Hong ditch	m	320	
4.1 San Mau stream	m	0	
4.2 San Mau stream	m	0	
4.3 San Mau stream	m	0	
4.4 San Mau stream	m	0	
4.5 San Mau stream	m	0	
4.6 San Mau stream	m	0	
5.1 Linh Bayou	m	0	
6.1 Linh Bayou	m	0	
Linh Stream	m	1150	
Procurement of O&M equipment	LS	1	High-Velocity Jet Truck, Vacuum Truck etc.

D: Diameter, B: Width, H: Height

Table 13-A-5 Breakdown of Sewage Flow for Alternative 2

Items	unit/ratio	Sub-area		Total	Remarks
		1.1	2 Area without North Area		
Population	persons	63,269	70,815	134,084	
Water Consumption	m^3/cap/day	165	165		
Sewage Ratio	80%	80%	80%		
House Connection Ratio	100%	100%	100%		
Domestic Sewage Flow	m^3/day	8,352	9,348	17,700	(1)×(2)×(3)
Infiltration Ratio	10%		935	935	(4)×(5)
Public Service Ratio	10%	835	935	1,770	(4)×(6)
Small Industry	10%	835	935	1,770	(4)×(7)
Total	m^3/day	10,022	12,153	22,175	(4)+(5)+(6)+(7)
Round Population	Persons	63,000	71,000	134,000	
Round Daily Average Flow	m^3/day	10,000	12,200	22,200	
Design Flow for STP2	**m^3/day**	**20,000**	**12,200**	**32,200**	

Project Costs

Table 13-A-4 Project Costs of Alterative 6

US $	= yen	82.6
US $	= VND	18,945
VND	= yen	0.00436

	Description	Foreign	Local	Total	Total
		Million yen	Million VND	Million yen	Million US$
A	**Construction Contracts**				
A.1	PACKAGE Groups: Site Work for STP2	0	28,178	123	1.5
A.2	Facilities	8,050	1,439,937	14,328	173.5
A.3	PACKAGE Groups: Canal Improvement	0	0	0	0.0
A.4	PACKAGE Groups: Maintenance Equipment	0	167,078	728	8.8
	Sub-total	8,050	1,635,193	15,179	183.8
B	**Contingencies**				
B.1	Physical Contingency	450	145,457	1,084	13.1
B.2	Price Contingency on Construction Works	942	1,273,943	6,496	78.6
	Sub-total	1,392	1,419,400	7,580	91.8
C	**Engineering Services**				
C.1	D/D, CB, IEC campaign SV and Survey Works	1,411	241,745	2,465	29.8
C.2	Physical Contingency	76	18,646	158	1.9
C.3	Price Contingency on Engineering Services	116	131,166	688	8.3
	Sub-total	1,603	391,556	3,310	40.1
	Total (A+B+C)	11,044	3,446,149	26,069	315.6
D	**Interest During Construction**	887	0	887	10.7
	Eligible Potion	11,931	3,446,149	26,956	326.3
E	**Cost for Land Acquisition and Supporting Resettlement**				
E.1	Base Cost	0	354,316	1,545	18.7
E.2	Physical Contingency	0	121,772	531	6.4
E.3	Price Contingency on Construction Works	0	51,591	225	2.7
	Sub-total	0	527,679	2,301	27.9
F	**Administration Cost**	0	179,376	782	9.5
G	**Vat**				
G.1	Vat (1) for Construction	0	305,459	1,332	16.1
G.2	Vat (2) for Engineering Services	0	39,156	171	2.1
	Sub-total	0	344,615	1,503	18.2
H	**Import tax**	0	253,305	1,104	13.4
	Non Eligible Potion	0	1,304,976	5,690	68.9
Total Project Cost		11,931	4,751,124	32,646	395.2

3. Project Costs Comparison

Table 13-A-5 Comparison Table of Project Costs

	Base	**Alternative 1**	**Alternative 2**
	million US$	million US$	million US$
Site Work	1.5	1.5	1.5
Sewerage Facilities	106.1	84.4	43.4
Drainage Facilities	77.0	51.2	30.0
2.1 Bien Hung Ditch Diversion	16.6	16.6	16.6
PS1	4.1	4.1	4.1
PS5	5.9	5.9	5.7
STP2	81.8	81.8	68.5
Canal Improvement	20.7	5.2	5.2
Maintenance Equipment	8.8	8.8	8.8
Total Construction Cost	322.5	259.5	183.8
Total Consulting Service Cost	32.0	30.8	29.8
Total Eligible Potion	**564.7**	**455.5**	**326.3**
Land Acquisition	31.7	27.9	27.9
Administration Cost	16.4	13.2	9.5
Vat	36.8	27.8	18.2
Import Tax	17.8	16.2	13.3
Total Non Eligible Potion	**102.7**	**85.1**	**68.9**
Total Project Cost	**667.4**	**540.6**	**395.2**