Chapter 13

LEGAL FRAMEWORK

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13.1 Principles of Setting Legislation

It is the first time for the Ho Chi Minh City (HCMC) people to possess a large scale of wastewater treatment facilities and systems. The facilities and systems would be operated and maintained by a state own enterprise and not by a private enterprise, which should be secured by the existing legislation and those that would be newly established.

Such legislation is generally composed of the following, also in Japan:

- Legislation related to the sewerage and drainage
- Legislation to conserve the living environment

The chapter has objectives to clarify how the Project should complete the above-mentioned legislation. Such legislation is aiming at stipulating the following:

- Drainage and sewerage activities
- Conservation of environment
- Design or construction of facilities for the drainage and sewerage: this should be prescribed separately in the tender documents; therefore, this chapter does not mention the legislation thereof.

(1) Legislation related to sewerage and drainage

There are some legislation pertaining to the sewerage and drainage; however, since this is the first time to treat and process the sewage with the facilities, such legislation should be strengthened in order to suit the coming circumstances after completion of the facility construction. Furthermore, the study under the project seeks to consider the point of collecting the wastewater treatment charge.

The legislation that have been enacted and are currently in application that concern wastewater treatment may be divided into two groups:

(a) Legislation empowering state agencies or state enterprises to treat sewage arising from various activities of the people. The reorganized UDC will be in charge of such treatment activities and will utilize the existing function of WSC for collecting the sewerage charge.

(b) Legislation prescribing the duty for private individuals or operators not to discharge sewage or any wastes into public waterways, or those prescribing the duty for operators or private individuals to take care of their own wastewater by treating it on qualities of discarded water for meeting the standards regulated by the legislation first in order that they might discharge the sewage through having undergone treatment into a natural

waterway.

(2) Legislation related to Environment Issues

This legislation stipulates environmental issues other than described in (1). Examples of such legislation in Japan are the following:

- Air Pollution Control Law: Aiming at pollution control by regulating the smoke emission generated from factories and business establishments
- Noise Regulation Law: Aiming at conservation of the living environment by regulating the noise generated from factories and business establishments
- Vibration Regulation Law: Aiming at conservation of the living environment by regulating the vibration generated from factories and business establishments
- Offensive Odor Control Law: Aiming at conservation of the living environment by regulating the odor substances generated from factories and business establishments
- Waste Disposal and Public Cleansing Law: Aiming at conservation of the living environment by suitable disposal of wastes
- Electric Utility Industry Law: Aiming at public safety and pollution control by regulating construction, operation and maintenance of electric facilities
- Fire Prevention and Extinction Law: Aiming at reduction of damage and injury caused by disasters by regulating fire prevention and extinction
- Law for Control of High Pressure Gas: Aiming at public safety by regulating the handling of high-pressure gas
- Poisonous and Deleterious Substance Control Law: Aiming at securing of safety by regulating handling of poisonous and deleterious substances
- Labor Safety and Health Law: Aiming at labor safety and health by making clear establishment of prevention and responsibility for labor accidents

The above-mentioned legislation is related to the qualification of the staff that is in charge of operation and maintenance of the drainage and sewerage facilities.

13.2 Legislation relating to Sewerage System in Japan

13.2.1 Legislation Related to Sewerage

In Japan the following laws are related to a wastewater treatment plant in addition to those described in 13.1 (2):

- Sewerage Law: stipulating guideline in management of public sewerage systems and regional sewerage systems
- Basic Law for Environmental Pollution Control: clarifying responsibility for pollution control by governments and business establishments
- Water Pollution Control Law: Aiming at pollution control by regulating the water

effluent generated from factories and business establishments
- Water Pollution Control Law: Aiming at pollution control by regulating the water effluent generated from factories and business establishments
- Regulations on Prevention from Radiation Injury: Aiming at prevention from radiation injury by regulating the handling of radioactive isotopes
- Emergency Measures Law for Construction of Sewerage Systems

13.2.2 Qualified Engineers Required in Japan

The following are qualified engineers required for operation and maintenance of a wastewater treatment plant, and are certified engineers who are ordained pursuant to the above-mentioned laws.

- Sewage Works Administrator: by the Sewerage Law, to manage and control a wastewater treatment plant and the related pump stations
- Certified Electric Engineer: by the Electric Utility Industry Law, to use electric facilities for receiving electricity
- Certified Hazardous Engineer: by the Fire Prevention and Extinction Law, to handle and store inflammables such as heavy oil used as a fuel
- Certified Oxygen Deficient Work Engineer: by the Labor Safety and Health Law, to enter the inside of tanks or vessels in order to inspect where oxygen may be short
- Radiation Protection Supervisor: by the Regulations on Prevention from Radiation Injury, to handle radioactive isotope, gas chromatography mass spectrometer or radioactive sludge densitometer for analysis of the water quality
- Specified Toxic Substance Engineer: by the Poisonous and Deleterious Substance Control Law, to analyze liquids in order to find organic phosphorus in use of poisonous chemical or medicine
- Specified Chemical Substance Engineer: by the Labor Safety and Health Law, to handle chlorine or ammonia for the wastewater treatment
- Crane Operator: by the Labor Safety and Health Law, to use crane machinery in order to maintain heavy equipment
- Crane Preparation Expert: by the Labor Safety and Health Law, to make preparation works for the crane use with rope or wire
- Gas Welding Engineer: by the Labor Safety and Health Law, to weld some parts with gasses such as acetylene

In addition, the following licensed persons are required for operating an organ or institution made up of fifty or more members:

- Safety Operator: by the Labor Safety and Health Law, to manage technical matters related to the safety
- Labor Operator: by the Labor Safety and Health Law, to manage technical matters related to the sanitary
- Industrial Medical Doctor: by the Labor Safety and Health Law

- Fire Preventive Officer: by the Fire Prevention and Extinction Law, to manage fire prevention and extinction

13.3 Present Situation of Legislation in Vietnam

13.3.1 Legislation Structure

The following legislation is related to the Project in Vietnam:

- Law
- Decrees
- Regulations
- Decisions

The decrees, regulations and decisions are generally explained as follows:

(a) Decrees are stipulated by the Government based on a proposal of a certain ministry, and sometimes provide an implementation guideline under a certain law or ordain sanctions against violations pursuant to a certain law.

(b) Regulations and standards are promulgated by ministries.

(c) Decisions are enacted by ministries, ministerial offices, and provincial or city People's Committees (PC).

13.3.2 Existing Legislation

(1) Legislation related to connection between private discharge and sewer system

The following decision stipulates the connection between private discharge sewer outlet and the sewer system:

- Construction Ministry's Decision on norms and standards for water works (water supply and sewerage) of houses and buildings (Decision No. 47/1999/QD-BXD), enacted on December 21, 1999

The decision includes the following contents:

- Connection of the private sewers and the sewerage system
- Installation of on-site / pretreatment facilities
- Wastewater handled

The paragraph describes briefly the contents.

(a) Connection of the private sewers and the sewerage system

- Article 1.3.2, Sewerage of new buildings can be connected to the existing sewerage system if investors get permissions from the related authorities.
- Article 1.6.3 & 1.6.3, In the case of no permission of the related authorities, it is prohibited to connect the building sewerage to the existing sewerage system.
- Article 3.11, Sewerage of new houses and buildings must be separated from sewerage of the old ones. If possible, each new house or building must be connected to sewerage system by separate pipes.
- Article 4.11.3, In the case of considering installation of necessary facilities in the future, design of the building must ensure this installation.
- Article 7.15.1, If on-site sewerage systems meet all the requirements, they must be connected to a general system.

(b) Installation of on-site / pretreatment facilities

- Article 1.5.2 & 1.6.6, In the case where the sewerage system does not meet the sanitary and safety standards, the related authorities require the owners to improve their sewerage system and to install necessary equipment.

It is understood that TCVN 5945 – 1995 Effluent Standards: Industrial Wastewater Discharges is applied as the above-mentioned standard; however, new standards should be stipulated as explained in the paragraph (2).

- Article 3.5, Sewerage of private houses and buildings can be connected to a general sewerage system of the city or their area.
  In the case where there is no public sewerage system or the public sewerage system rejects the wastewater, the sewerage of building must be connected to an on-site wastewater treatment system.
- Article 3.7, Industrial wastes that can be harmful to a wastewater treatment station (plant) must be eliminated and handled by on-site treatment facilities.

(c) Wastewater handled

- Article 3.6, It is prohibited to discharge the wastes such as coal, domestic wastes, ash, flammable substances, exploders... into the sewerage system.
- Article 7.15.3, It is prohibited to discharge wastewater of food-processing factories and canteens directly to on-site wastewater treatment systems.
- Article 8.10.4, Wastewater must run through a filter, if it carries grits.
- Article 8.11.1, Chemical and industrial wastes will destroy sewerage system, cause much maintenance costs and affect wastewater treatment processing. Therefore, before discharging chemical and industrial wastewater to a general sewerage system, preliminary treatment has to be taken. Preliminary

treatment plans and technologies must be approved by the local authorities

- Article G2, Investors who want to install, build or build any gray water system must get permissions of related authorities. Where, gray water is wastewater of households without body wastes.

(2) Legislation related to environment issues

The Project should be established also in compliance with the Law on Environmental Protection (EPL). The national assembly enacted the law in December 1993, pursuant to the Constitution of Vietnam.

(a) Legislation related to sewerage system

The following are the legislation related to the sewerage system:

- Law on Environmental Protection (EPL): EIA Report for new activities / projects affecting the environment should be submitted to State Management Agency for appraisal of the environmental protection.
- Decree 175, Providing Guidance for Implementation of the Law on Environmental Protection
- Decree 26, Providing Regulations on Punishment of Administrative Violation of Environmental Protection
- Law on Water Resources, stipulating exploration and use of water resources

The following legislation ordains matters related to the environment under the EPL:

- TCVN 5298 – 1995 Requirements for Use of Wastewater and Sludge for Watering and Fertilizer Purposes
- TCVN 5524 – 1995 General Requirements for Protecting Surface Water against Pollution
- TCVN 5525 – 1995 General Requirements for Protection of Underground Water
- TCVN 5937 – 1995 Air Quality: Ambient Air Quality Standards, specifying maximum allowable concentrations on the common pollutants in the ambient air.
- TCVN 5938 – 1995 Air Quality: Maximum Allowable Concentrations of Hazardous Substances and Dusts, specifying maximum allowable concentrations of hazardous substances in the ambient air including inorganic and organic toxic substances.
- TCVN 5939 – 1995 Air Quality: Industrial Emission Standards for Inorganic Substances and Dusts, specifying maximum allowable concentrations of inorganic substances in industrial emissions discharged to the atmosphere.

- TCVN 5940 – 1995 Air Quality: Industrial Emission Standards for Organic Substances, specifying maximum allowable concentrations of organic substances in industrial emissions discharged to the atmosphere.
- TCVN 5941 – 1995 Soil Quality: Maximum Allowable Limits of Pesticides Residues in the Soil, specifying maximum allowable limits of pesticide residues in the soil.
- TCVN 5942 – 1995 Water Quality: Surface Water Quality Standards specifying parameters and their maximum allowable concentrations in surface water.
- TCVN 5943 – 1995 Water Quality: Coastal Water Quality Standards specifying parameters and their maximum allowable concentrations in coastal water.
- TCVN 5944 – 1995 Water Quality: Ground Water Quality Standards specifying parameters and their maximum allowable concentrations in ground water.
- TCVN 5945 – 1995 Effluent Standards: Industrial Wastewater Discharges specifying pollutants and their maximum allowable concentrations in industrial wastewater discharged to the public water bodies.
- TCVN 5998 – 1995 Guidance on sampling Marine Waters
- TCVN 5999 – 1995 Guidance on sampling of Wastewater

(b) Legislation related to wastewater discharges

The following standards should be used for examining the discharge from commercial and business establishments:

- TCVN 5945 – 1995 Effluent Standards: Industrial Wastewater Discharges

The standards do not handle storm-water. Values of parameters and concentration of substances contained in industrial wastewaters are stipulated as follows separately per water bodies that the wastewater is discharged into:

A) Those provided for sources of drinking water.

B) Those such as river and canal water provided for aquatic breeding, navigation, irrigation, etc.

C) Those of sewer water discharged to be treated by authority agencies

Qualities of effluents yielded by the wastewater treatment facilities are stipulated depending on where the fluent is discharged. In the case where the effluent is reused for drinking, the stipulation is the strictest in the qualities.

TABLE 13.1 MAXIMUM PERMISSIBLE CONCENTRATION OF POLLUTANTS FOR DISCHARGE OF INDUSTRIAL WASTEWATER (TVCN 5945-1995)

Parameter	Unit	Maximum Permissible Concentration		
		A	B	C
BOD_5 (20°C)	mg/l	20	50	100
COD	mg/l	50	100	400
Suspended Solids	mg/l	50	100	200

The legislation shows the following:

- Water qualities of the effluent discharged are stipulated only in TCVN 5945 – 1995 Effluent Standards.
- The effluent from the Wastewater Treatment Plant should obey the "B" standards of TCVN 5945 – 1995.
- The effluent discharged from the Project sewerage system should follow the "C" standards of TCVN 5945 – 1995 unless otherwise prescribed. However, the standards C cannot be applied to the users because the contents are highly severer than those of Japan on BOD, COD and Suspended Solids (SS) as illustrated in Table 13.2.

(c) Legislation related to punishment of administrative violation of environmental protection

The following decree stipulates the punishment against administrative violation of the environmental protection:

- Decree 26, Providing Regulations on Punishment of Administrative Violation of Environmental Protection

The following paragraphs outline key contents of this decree, relating to the Project:

- Warning or fines of VND 500,000 at the maximum would be applied against non-treatment of wastewater before the discharging (Article 15)
- The chairman of PC at different levels has the right to punish the violation (Article 4)
- Department of Science, Technology and Environment (DOSTE) has the right of inspection for the environmental protection (Article 4)
- Jurisdiction of maximum amounts on the fines for the violation is stipulated for DOSTE inspectors and the chief of the inspection team, severally (Article 20).

The following are parts related to the project in the Decree 26:

(Right of PCs and DOSTE)

- Article 4, Delegation of the power for administering penalties to administrative violation(s) of environmental protection
    1. People's Committee chairman at different levels has the right to punish administrative violations(s) of environmental protection on their localities.
    2. The chief of inspector and inspectors for environmental protection of the Ministry of Science, Technology and Environment, the Bureau of Environment, the Department of Science, Technology and Environment have power to punish the administrative violation of environmental protection.

(Punishment against environmental pollution)

- Article 6, Violation of the prevention of the environmental pollution causing bad effects to the environment
    3. A fine of VND 2,000,000 to VND 5,000,000 shall be applied to any one of following acts of violation:
        a. Entities failing to submit or submit on time EIA report of projects or operating units, which are appraised by State Bodies in accordance with the list issued by the State Management Body for Environmental Protection.
        b. Entities failing to obey or incorrectly obeying the requirements stated in the appraisal form or the license to the environmental license issued by the State Management Body for Environmental Protection.

(Punishment against non-treatment of wastewater)

- Article 15, Violation(s) of transportation and treatment of wastewater and solid wastes
    1. Warning or fines ranging from VND 100,000-500,000 will be applied to the following:
        a. Entities who transport solid wastes and /or environmental pollutants, failing to comply with State regulations stipulated in the Environmental Protection Law.
        b. Non-treatment of wastewater and solid wastes before discharging as regulated by the State.

(Functions of DOSTE and PCs)

- Article 20, Jurisdiction for handling down penalties to violations entities
    1. Inspectors of the Provincial and Central Government Department of Science, Technology and Environment (DOSTE), of the NEA, and of the MOSTE performing their duties are empowered to apply regulations stated in Term 1 of Article 34 which is stipulated in the Legal Order on

Penalties for Administrative Violations, i.e.:

- Applying warnings and monetary penalties up to VND 200,000 to violations in their management locations;
- Confiscating violating entities asset and means causing environmental pollution worth up to VND 500,000;
- Forcing entities and/or individual(s) violating State environmental protection law to stop violating, to restore the environment to its pre-damaged state, to overcome consequences caused by the violation(s) and to dispose of material causing damage to the environment.

2. Chief of the inspection Teams of all the DOSTE(s) are empowered to apply regulations stated in Term 2 of Article 34 which is stipulated in the State Legal Order on Penalties for Administrative Violations, i.e.:
   - Applying warning and monetary penalties up to VND 10,000,000;
   - Revoking license approved by the DOSTE;
   - Confiscating the violating entities' asset(s) and means causing environmental pollution;
   - Forcing entities and/or individual(s) violating State Environmental Protection to pay compensation for losses and damages caused by violation(s) an amount of up to VND 1,000,000, to restore environment to its pre-damaged state, to overcome consequences caused by violation(s) and to dispose of material causing damage to the environment.

3. Chief of the inspection Teams of the MOSTE and the NEA are empowered to apply regulations stated in Term 3 of Article 34 which is stipulated in the State Legal Order on penalties for Administrative violations, i.e.:
   - Applying warnings and monetary penalties up to VND 20,000,000;
   - Revoking licenses approved by the MOSTE and the NEA;
   - Confiscating the violating entities' asset(s) and means causing environmental pollution;
   - Forcing entities and/or individual(s) violating State Environmental Protection Law to pay compensation for losses and damages by violation(s) an amount of up to VND 1,000,000 to restore the environment causing damage to the environment.

4. Chairmen of sub-provincial People's Committees are empowered to apply penalties for administrative violations of environmental protection stated in Article 26 in the State Legal Order on Penalties for Administrative Violations stated in Chapter II on this Decree within their own jurisdiction of environmental protection.

13.3.3 Existing Qualification System

There exists a similar qualification system in Vietnam as for the following engineers:

- As the Sewage Works Administrator, Sewerage Engineer to study a sewerage network and wastewater treatment.
- Certified Electric Engineer
- Radiation Protection Supervisor
- Specified Toxic Substance Engineer: the tasks by the Specified Toxic Substance Engineer are performed in Vietnam by chemical engineers with graduation of the chemical education and environmental engineers who know a process to treat wastewater.
- Crane Operator
- Crane Preparation Expert in the port area: mechanical engineers could cover the task of the Crane Preparation Expert.
- The tasks of the Certified Hazardous Engineer require experience or graduation of the chemical education.
- The chemical engineer could cover the task of the Specified Chemical Substance Engineer.

There are no specified engineers in Vietnam for the tasks of the following:

- Safety Operator
- Labor Operator
- Industrial Medical Doctor
- Fire Preventive Officer

A large scale of factories or establishments may assign in Vietnam persons for the tasks similar to those of the Safety Operator and the Industrial Medical Doctor and form a fire-fighting team. Technical Engineers could cover the tasks of the Safety Operator, Labor Operator, and Fire Preventive Officer.

13.4 Legislation relating to SDC

It is planned at present that reorganized Urban Drainage Company (Sewerage and Drainage SDC, called as “SDC” hereinafter) would be in charge of the sewerage and drainage activities for the operation and the maintenance. SDC should be furnished with the following new functions:

- Operate and maintain the new facilities,
- Plan the expansions of the facility capacity,
- Supervise the maintenance works of the systems of Level 4 and smaller,

- Perform related commercial activities and;
- Handle the financing matters.

The following would be the requirements in the legislation:

- SDC would be run in compliance with the Government's Laws.
- PC HCMC would enact decision (Decision) for SDC based on Law of State Enterprises and related decrees to supplement its activities.
- Depending on forms and grades of the activities, it is necessary to get approvals of the Government or the ministries in charge or PC HCMC.

The contents, included as the stipulation in the Decisions, are classified as follows:

- Requirements for running of SDC
- Services and activities of SDC
- Financing for operation and maintenance of SDC

13.4.1 Requirements for running of SDC

The Decision would ordain the laws, decrees and regulations that it be pursuant to as follows:

- Relation to the Law on Environmental Protection (EPL), other laws, decrees and regulations
- In addition to the EPL, SDC should run under the Laws of Enterprises.

The Decision might stipulate the following that are required for running SDC:

(a) Permission to treat wastewater and running of SDC

The Decision empowers SDC to treat the wastewater at the Project area to run SDC.

(b) Report to DTPW

SDC would be of a State Own Enterprise (SOE) and should report DTPW of HCMC on the activities.

At present, UDC maintains the sewers of Level 1, 2 and 3, but does not Level 4. In the case where SDC includes the Level 4 as the scope, it may be necessary to report the activities directly to PC HCMC. The PC HCMC would decide the management for the Level 4 in the future.

13.4.2 Services and Activities of SDC

The services and activities of SDC are classified as follows on the contents:

- Drainage and sewerage services
- SDC Organization

(1) Drainage and Sewerage Services

SDC is responsible for operation and maintenance of the Wastewater Treatment Plant out of the Facilities in addition to the existing sewer system. The standards of the effluent that is generated from the Wastewater Treatment Plant are ordained in order to control water pollution in the public waters, as "B" of TVCN-1995 explained in 13.3.2 (2).

SDC might also supervise the maintenance work of the systems of Level 4 and smaller in addition to the systems of Level 1, 2 and 3 that have been conducted by UDC. However, because District PCs or Ward PCs are responsible for the work at present; therefore, the PC HCMC might promulgate the Decision for the management. Realistic procedures to form organization on the sewer maintenance and to establish the legislation should be further studied in the period of Detailed-Design Review (Review of D/D) starting at June 2001.

Projects to treating the wastewater in HCMC will discharge the effluent into the Saigon River or the public water body; therefore, it may have to unify the quality standards on the river and canal water.

DOSTE is responsible for formulating and enforcing environmental regulations. The Project has a wastewater treatment plant while the World Bank does primary treatment facilities. DOSTE recognizes that the latter is in a first step; therefore, DOSTE accepted the effluent qualities. The second step or the third following the first step will be implemented; however, requires the investment.

Environmental management should be based on economic conditions. Financing of 200 million US$ or more is required for collection of wastewater if the legislation is set completely. This means that the step-by-step management is necessary. DOSTE expects success in the World Bank project in collecting the wastewater, waiting the next steps.

(2) SDC Organization

Organization of SDC should be planned in view of the functions required. The following, required for the organization, might be newly set and stipulated if necessary:

- Management System
- Head Office

- Wastewater Treatment Plant
- Pumping Stations

It would be important to stipulate how the facilities are managed in the course where the privatization thereof is studied in the future.

13.4.3 Financing for Operation and Maintenance of SDC

The following contents would be stipulated in the Regulation or Decision:

- Subsidy or budgetary allocation for the establishment and operation / maintenance of SDC
- Tariff setting and enforcement of collection for running SDC
- Accounting of SDC

(1) Subsidy or Budgetary Allocation

The charge revenue may not cover fully the operation and maintenance costs of SDC. SDC should be subsidized from the PC HCMC or the Central Government in order to complement such shortage in the cost.

The above-mentioned is interpreted based on the stipulation of the decree of No. 90/1998/ND-CP. Procedures for the budgetary allocation would be stipulated in the Decision or Regulation if necessary.

(2) Tariff Setting and Enforcement of Collection

The PC HCMC promulgated Decision of No. 10/2001/QD-UB on implementation of sewerage-charge collection in HCMC, where the following are prescribed:

- The sewerage charge should be collected in order to supplement the budget for investment and maintenance, which is applied from the first of July 2001.
- The tariff of the charge should be calculated to be 12% of the clean water bill.
- HCMC Water Supply Company (WSC) should be responsible for the accurate and sufficient collection.

SDC might modify the tariff if necessary in the future with approval of the PC HCMC.

(3) Accounting of SDC

The accounting activities should be conducted in compliance with the Accounting Standards that are established by the Ministry of Finance (MOF). The following organs of the PC HCMC would supervise the regulation and monitoring of SDC in the application of the accounting standards:

- HCMC Department of Finance (HCMC DOF)
- HCMC Tax Department (HCMC TD)
- HCMC Capital Management Department (HCMC CD)

HCMC CD and HCMC TD would hold responsibility for examination and approval of financial statements of SDC.

UDC reports the performance results currently in use of indicators of "Key Performance Indicators", but the indicators may change in the future. It might be stipulated in the Decision if necessary.

13.5 Legislation Relating to Others

These items would not be stipulated in the Regulations for activities of SDC, but partly stipulated in existing decision on the following:

- Wastewater qualities to be treated
- Damage liability, penalty and fine

13.5.1 Wastewater qualities to be treated

The matters related to the wastewater qualities are classified as follows:

- Effluent standards on wastewater discharges
- Stipulation on connection between private sewers and the sewer system
- Monitoring and inspection of the sewage discharged

(1) Effluent standards on wastewater discharges

The quality of the wastewater discharged to the sewerage system should be stipulated as the restrictions. The illegal discharge should be prohibited from the following view:

- Protect the valuable facilities and systems of SDC
- Conserve human health and the living environment

The following contents are stipulated to abide the TCVN 5945 – 1995 Effluent Standards: Industrial Wastewater Discharges.

- Restrictions on the wastewater discharged in use of the sewerage
- Prohibition of illegal discharge of such effluents outside the restrictions for treatment of the wastewater treatment plant

At present there are no other standards that stipulate the effluent qualities than TVCN

5945. However, the standards C cannot be applied to the users of the project system because the contents are severer than those of Japan. Table 13.2 illustrates comparison of the standards between the standards C and the Effluent Standards for Users of Public Sewers with Wastewater Treatment Plants in Japan. In the Effluent Standards of Japan BOD and Suspended Solids are specified 600 and 600 mg/l, respectively while the standards C of Vietnam those are 100 and 200.

Consequently, it is necessary to promulgate new standards for the users of the project system in view of the present pollution state in Vietnam.

Installation of an on-site treatment on new building is stipulated to require the permission before the construction. The Decision No. 47/1999/QD-BXD stipulates standards on design and construction of a new building, enacted by the Ministry of Construction. The stipulation includes the structure technology, design of the septic tanks, the effluent thereof and the technology or process handling the organic components.

DOSTE has a right of entering the polluter's facilities to inspect whether they obey the rule or not. SDC should submit such application to DOSTE for the inspection; then, this duty will follow if agreed.

(2) Stipulation on connection between private sewers and sewer system

The factories that may generate the following illicit discharge should be furnished with the pretreatment facilities at on-site for discharge to the sewerage system:

- May interfere the function of the wastewater treatment plant and may cause damage to the facilities
- May worse the effluent from the wastewater treatment plant
- May include considerable volume of substances harmful to human health and living environment

Population served by the sewer will increase in the Project area. The following should be stipulated in the Regulation:

- To provide new building with the proper system to connect to the sewerage system
- To improve the existing building for provision with the proper system to connect to the sewerage system at the time of changing building

The following contents are stipulated to obey the Construction Ministry's Decision on norms and standards for water works (water supply and sewerage) of houses and buildings (Decision No.: 47/1999/QD-BXD):

- Obligation to install facilities for the on-site treatment by users in order to abide the

premises
- Obligation to provide new building with the proper system to connect to the sewerage system

Specified facilities will have to be regulated for prevention of water pollution. Such regulating should be ordained in a certain law; in Japan, they are on the discharge standards in the Water Pollution Control Law.

This issue is separately discussed as "Promotion of installation of on-site / pretreatment facilities" in 13.6 (2).

(3) Monitoring and inspection of sewage discharged

SDC is responsible for monitoring of the wastewater discharged on whether they abide the discharge restrictions or not.

Illicit discharge may exceed the standards stipulated on the discharge restriction. Such discharge should be prevented from flowing in the facilities and systems of SDC. The order stops such discharge for a certain period.

Inspectors for SDC would have the right to enter the polluter's facilities in order to inspect the discharge facilities, the specified facilities and / or the pretreatment facilities for discharge to the sewerage system.

Furthermore, such activities should comply with the Decree 26, Providing Regulations on Punishment of Administrative Violation of Environmental Protection. The following contents should be partly stipulated in the Regulation or Decision.

- Monitoring of the wastewater discharged from users
- Right of rejecting of such discharge to treat or of ordering to stop the discharge for SDC
- Right of entering the polluters' facilities to inspect

13.5.2 Damage liability, penalty and fine

The following contents should be stipulated in certain legislation:

- Punishment or penalties against the non-payment case
- Punishment or penalties against damages caused to the facilities of SDC

Activities such as damage liability, penalty and fine should comply with the Decree 26, Providing Regulations on Punishment of Administrative Violation of Environmental Protection.

(1) Non-payment case

It is anticipated that the non-payment cases will be greater than in the case of the other utilities because the sewerage charge is first introduced to HCMC. The stop of tap water is much easier and more effective in the case where the charge has a structure based on the water bill.

In other countries, the principle of one stop payment is used where the state can stop services of any kind if one service is mot being paid. The countermeasure against the non-payment case should be stipulated in the Regulation mentioned in the section 4 to utilize the Decree 26.

The tariff of the charge was settled to have a structure based on the water bill of Water Supply Company (WSC). At present, in case where the customers do not make the payment after 30 days from the date of issuing bills, WSC will stop supplying water after its third notice.

DOSTE does not currently consider setting any measures against no-payment cases at present. Business or commercial establishments have no way for the discharge in the case where the organ rejects to receive the discharge thereof. Therefore it would be reasonable that the polluter should pay fines in the case of no-payment or illegal discharge. The ward or district levels stipulate such fines for administrative violation; consequently, it would be realistic for the levels to collect such fines.

(2) Damage liability burden

SDC processes the valuable facilities of the wastewater treatment plant and the pump stations. Penalties or fines should be stipulated against damages caused to the facilities through revision on necessary parts in the Decree 26.

At present the Article 15 of Decree 26 stipulates warning or fines ranging from VND 100,000 – 500,000 for non-treatment of wastewater before discharging as regulated. The fine amounts are much small considering that illegal discharge of such non-treated wastewater may affect badly the performance of the wastewater treatment plant. The following contents should be considered in the revision of the decree.

- The polluters who illegally discharge to the wastewater treatment plant will have to pay fines and will be liable to any damages caused to the facilities and systems. The fines are sometimes set at four times the daily costs of the facilities in other countries.

13.6 Supporting System

(1) Integrated flood control

Rapid urbanization of peripheral HCMC is expected in the City Master Plan. Pattern of storm-water concentration will diversely change, as the urbanization and housing development will progress. It is anticipated that drainage facilities may not catch up development of the urban area at a capacity to handle the drainage. Flood control measures may be integrated with non-structural ones such as catchment area development plan and land-use plan, where developer's obligation to provide retention pond, utilization of low-laying agricultural land as natural flood plan, etc. are planned. Legal arrangement and organizational setup to enable such non-structural measures shall be sought for.

(2) Control of groundwater exploitation

The protecting of underground water is prescribed in the Law on Water Resource, Article 12 as well as TCVN 5525 – 1995 General Requirements for Protection of Underground Water. However, there is no enforceable control over more than 100,000 groundwater wells, of which at least 200 are of the capacity over 1,000 m^3/day yield. The relate officials indicate concern on possible drawdown of aquifer table, salinity intrusion or even land subsidence. Mechanisms for effective control of groundwater exploitation should be instituted. Measures to quantify the groundwater yield and hence wastewater generation should be sought for.

(3) Control of water qualities of public water body

The projects to treat the wastewater in HCMC will discharge the effluent into the river; therefore, it should unify the quality standards on the effluent. Article 18-2 of the Law on Water Resource stipulates the following:

- The granting of permit to discharge wastewater into the water source must be based on the capacity of receiving wastewater of the water source and the assurance of no pollution of the water source and the protection of the water resource.

  The Government shall make concrete provisions on the issuing of permit to discharge wastewater into a water source.

The Project has a wastewater treatment plant while the World Bank does primary treatment facilities. DOSTE recognizes that the latter project is in a first step, the second step or the third following the first step would be implemented to satisfy the effluent requirements.

(4) Promotion of installation of on-site / pretreatment facilities

Surveys of industrial pollution* shows that most of business establishments lack on-site or pretreatment facilities and that only a few have primary sedimentation tanks or septic

tanks.

* Note: Overview on pollution of typical industrial areas in HCMC (Black Books of 1994 and 1997) issued by DOSTE and HCMC Environmental Improvement Project in 1998.

As illustrated in Table 13.2 the maximum allowable figure of COD is not specified in the Effluent Standards of Japan. Figures of COD should be calculated from those of BOD getting the interrelation expression between BOD and COD. Here it is assumed that COD is equal to BOD.

Users of the sewerage system would have to install the pretreatment or on-site facilities in the case where they would discharge the waste whose BOD or COD excesses 600 mg/l. Table 13.3 to 13.8 illustrate the results of analysis of such users in the surveys, showing that they have the following characteristics:

- Industries of paper, textile, and food processing tend to discharge a large amount of the waste at COD more than 600 mg/l (Table 13.3).
- Food processing industries might discharge the waste at high BOD (Table 13.4).
- Industries of food processing, cotton, weaving & dyeing, brewery, and piggery farm are anticipated to discharge the waste at high COD (Table 13.5).
- Industries of weaving & dyeing, paper, textile, and food processing might discharge the waste at a large COD load (Table 13.6).
- Industries of weaving & dyeing, polishing & plating metals, chemical (antiseptic), electricity, steel, glass and insecticide might discharge the wastes including toxic substances (Table 13.8). Unless restricted in the legislation, the composts would include such substances at a high density.

As the results installation of the on-site / pretreatment facilities should be promoted to the following industries:

* Weaving & dyeing
* Paper
* Textile
* Food / meat processing
* Polishing & plating metals
* Chemical (antiseptic) or Insecticide
* Electricity

The promotion program may include also the following:

- Furnish a subsidy program where the loan could be utilized in the advantageous conditions for the installation. It may be difficult to set the tax exemption or tax holidays as a program because it is managed by the Central Government.
- Give a suspended period in which the business establishment could run discharging the wastes only before they install the facilities.

- Form a technical advisory team to advise to the business establishments a way to treat the wastes in the facilities for the standards.

The following paragraphs explain the procedures on handling the discharge as an example where one business establishment runs discharging the waste at a higher COD without pretreatment facilities:

i) Activities of the public relation and socialization are performed by PMU for promulgating new effluent standards

ii) The new standards are promulgated to stipulate the discharge qualities.

iii) The business establishment applies to SDC in order that the establishment might obtain a suspended period or a grant period in which they could run discharging the waste at the same COD only before construction of the facilities.

iv) SDC or DTPW introduces to them the technical advisory team to advise in treating the waste, and suggests to them the subsidy program where they can utilize a loan in advantageous conditions.

v) After completing construction of the facilities, SDC conducts the water analysis of the discharge under management of DOSTE in order to confirm the qualities for the standards.

PROCEDURES OF INSTALLATION OF PRETREATMENT FACILITIES

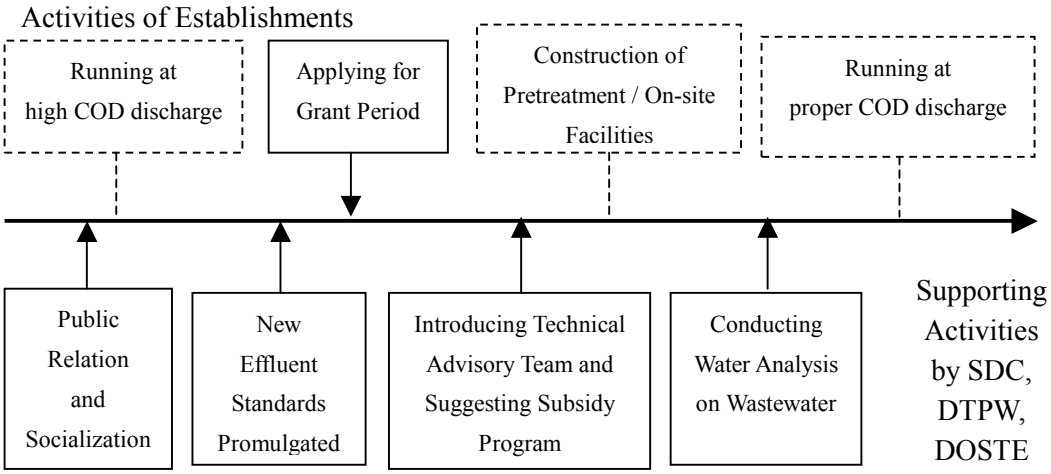

TABLE 13.2 COMPARISON OF EFLLUENT STANDARDS

No.*	Parameter	Unit	Japan	Vietnam
			Effluent Standards*[2]	C of TCVN 5945-1995*[3]
1	Temperature	°C	45 (40)*[4]	45
2	PH		5 - 9	5 - 9
3	BOD	mg/l	600 (300)*[4]	100
4	COD	mg/l	-	400
5	Suspended Solids	mg/l	600 (300)*[4]	200
6	Arsenic	mg/l	0.5	0.5
7	Cadmium	mg/l	0.1	0.5
8	Lead	mg/l	1	1
9	Residual Chlorine	mg/l	-	2
10	Chromium (VI)	mg/l	0.5	0.5
11	Chromium (III)	mg/l	2	2
12	Mineral Oil and Fat	mg/l	5	5
13	Animal-vegetable Fat and Oil	mg/l	30	30
14	Copper	mg/l	3	5
15	Zinc	mg/l	5	5
16	Manganese	mg/l	10	5
17	Nickel	mg/l	-	2
18	Organic Phosphorus	mg/l	1	1
19	Total Phosphorus	mg/l	-	8
20	Iron	mg/l	10	10
23	Mercury	mg/l	0.005	0.01
27	Fluorine	mg/l	15	5
28	Phenols	mg/l	5	1
30	Cyanide	mg/l	0.2	1
	Alkyl-mercury		Undetectable	-
	Polychlorinated Biphenyl (PCB)	mg/l	0.003	-
	Iodine Consumption	mg/l	220	-

Note: * Numbers given to the parameters in TVCN 5945 – 1995: Effluent Standards: Industrial Wastewater Discharges

*[2] Effluent Standards for Users of Public Sewers with Wastewater Treatment Plants

*[3] Industrial wastewater discharged into water bodies of sewer to be treated by authority agencies

*[4] The figures are applied for manufacturers.

[5] Parameters of Vietnam are set to be severer than those of Japan.

[6] Parameters of Japan are set to be severer than those of Vietnam.

Sources: Overview on pollution of typical industrial areas in HCMC (Black Books of 1994 and 1997) issued by DOSTE and HCMC Environmental Improvement Project in 1998. Numbers in the tables are those of the business establishments listed in the above-mentioned surveys.

TABLE 13.3 INDUSTRIES OF LARGEST DISCHARGE

No.	Type of Industry	Wastewater generated (m^3/d)	COD (mg/l)
29	Textile	6,500	654
77	Paper	3,700	1,200
79	Paper	3,000	1,850
51	Meat Processing	1,500	1,840
80	Paper	1,000	2,000
94	Paper	1,000	1,850
70	Weaving & Dyeing	800	8,500
82	Food Processing	650	735
96	Paper	500	1,500
25	Textile	400	6,570

TABLE 13.4 INDUSTRIES OF HIGHEST BOD

No.	Type of Industry	Wastewater generated (m^3/d) (a)	BOD (mg/l) (b)	BOD Load (mg/l- m^3/d) (a) x (b)
13	Food Processing		8,500	
4	Sea Food Processing	160	1,800	288,000
15	Sea Food Processing	20	1,230	24,600

TABLE 13.5 INDUSTRIES OF HIGHEST COD

No.	Type of Industry	Wastewater generated (m^3/d) (a)	COD (mg/l) (b)	COD Load (mg/l- m^3/d) (a) x (b)
56	Food Processing	50	21,258	1,062,900
35	Cotton		21,000	
70	Weaving & Dyeing	800	8,500	6,800,000
9	Brewery		6,704	
86	Meat Processing	400	6,570	2,628,000
93	Piggery Farm	195	3,000	585,000
92	Piggery Farm	25	3,000	75,000
31	Textile		2,860	
85	Meat Processing	300	2,215	664,500
94	Paper	1,000	2,000	2,000,000

TABLE 13.6 INDUSTRIES OF LARGEST COD LOAD

No.	Type of Industry	Wastewater generated (m^3/d) (a)	COD (mg/l) (b)	COD Load (mg/l- m^3/d) (a) x (b)
70	Weaving & Dyeing	800	8,500	6,800,000
79	Paper	3,000	1,850	5,550,000
77	Paper	3,700	1,200	4,440,000
29	Textile	6,500	654	4,251,000
51	Meat Processing	1,500	1,840	2,760,000
86	Meat Processing	400	6,570	2,628,000
94	Paper	1,000	2,000	2,000,000
80	Paper	1,000	1,850	1,850,000
56	Food Processing	50	21,258	1,062,900
96	Paper	500	1,500	750,000

TABLE 13.7 INDUSTRIES OF POSSIBLE DISCHARGE OF TOXIC SUBSTANCES

No.	Type of Industries	Wastewater generated (m^3/d)	Wastewater Characteristics	Wastewater Treatment	Location Discharging Wastes
	6. Arsenic				
33	Chemical			None	Canal
61	Chemical (Antiseptic)	20	COD: 297	Primary Sediment.	Canal
71	Chemical (Antiseptic)	15	COD: 280	Biological & Chemical	Canal
62	Insecticide	20	COD: 375	Sediment.	Canal
	7. Cadmium				
8	Electricity			None	Canal
74	Electricity			None	River
11	Polishing & Plating metals		COD: 105-226	None	Public Sewer
18	Polishing & Plating metals	8	Cr: 28, Ni: 16.7	None	Public Sewer
10	Weaving & Dyeing	70		None	Public Sewer
32	Weaving & Dyeing	200	COD: 600		Public Sewer
49	Weaving & Dyeing			None	Public Sewer
52	Weaving & Dyeing	80		Chemical Treatment	Public Sewer
70	Weaving & Dyeing	400-800	COD: 980- 8,500	None	Public Sewer
100	Weaving & Dyeing	30	COD: 1,200	None	Canal

8. Lead

8	Electricity			None	Canal
74	Electricity			None	River
2	Glass		COD: 1,180	Oil Separat. Tank	Canal
17	Glass	50	COD: 180	None	Canal
26	Glass	100		None	Public Sewer
11	Polishing & Plating metals		COD: 105-226	None	Public Sewer
18	Polishing & Plating metals	8	Cr: 28, Ni: 16.7	None	Public Sewer
10	Weaving & Dyeing	70		None	Public Sewer
32	Weaving & Dyeing	200	COD: 600		Public Sewer
49	Weaving & Dyeing			None	Public Sewer
52	Weaving & Dyeing	80		Chemical Treatment	Public Sewer
70	Weaving & Dyeing	400-800	COD: 980- 8,500	None	Public Sewer
100	Weaving & Dyeing	30	COD: 1,200	None	Canal

10. Chromium (IV)

24	Cast Iron			None	Public Sewer
37	Leather	30	COD: 1,410 Cr: 0.415	None	Public Sewer
50	Leather	50	COD: 1,210	None	Public Sewer
11	Polishing & Plating metals		COD: 105-226	None	Public Sewer
18	Polishing & Plating metals	8	Cr: 28, Ni: 16.7	None	Public Sewer
36	Steel			None	Public Sewer
73	Steel			Primary Sediment.	Canal
10	Weaving & Dyeing	70		None	Public Sewer
32	Weaving & Dyeing	200	COD: 600		Public Sewer
49	Weaving & Dyeing			None	Public Sewer
52	Weaving & Dyeing	80		Chemical Treatment	Public Sewer
70	Weaving & Dyeing	400-800	COD: 980- 8,500	None	Public Sewer
100	Weaving & Dyeing	30	COD: 1,200	None	Canal

18. Organic Phosphorus

61	Chemical (Antiseptic)	20	COD: 297	Primary Sediment.	Canal
71	Chemical (Antiseptic)	15	COD: 280	Biological & Chemical	Canal
62	Insecticide	20	COD: 375	Sediment.	Canal

23. Mercury

61	Chemical (Antiseptic)	20	COD: 297	Primary Sediment.	Canal
71	Chemical (Antiseptic)	15	COD: 280	Biological & Chemical	Canal
8	Electricity			None	Canal
74	Electricity			None	River
62	Insecticide	20	COD: 375	Sediment.	Canal

30. Cyanide

24	Cast Iron			None	Public Sewer
11	Polishing & Plating metals		COD: 105-226	None	Public Sewer
18	Polishing & Plating metals	8	Cr: 28, Ni: 16.7	None	Public Sewer
36	Steel			None	Public Sewer
73	Steel			Primary Sediment.	Canal

TABLE 13.8 SUMMARY ON INDUSTRIES OF POSSIBLE DISCHARGE OF TOXIC SUBSTANCES

Type of Industries	Number of Establishments (a)	6. Arsenic	7. Cadmium	8. Lead	10. Chromium (VI)	18. Organic Phosphorus	23. Mercury	30. Cyanide	Number of Os (b)	Priority (a) × (b)
Weaving & Dyeing	6		O	O	O				3	18
Polishing & Plating Metals	2		O	O	O			O	4	8
Chemical (Antiseptic)	2	O				O	O		3	6
Electricity	2		O	O			O		3	6
Steel	2				O			O	2	4
Glass	3			O					1	3
Insecticide	1	O				O	O		3	3
Leather	2				O				1	2
Cast Iron	1				O			O	2	2

Chapter 14

COST ESTIMATE AND IMPLEMENTATION SCHEDULE

CHAPTER 14 COST ESTIMATE AND IMPLEMENTATION SCHEDULE

14.1 Cost Estimate

14.1.1 General

Based on the review of the Feasibility Study (FS), the project cost of the entire project is estimated under the present economic condition.

The project consists of the following seven (7) main components;

- Tau Hu – Ben Nghe canal improvement,
- Pump drainage improvement for Thanh Da, Ben Me Coc (1) and (2) areas,
- Existing main combined sewer improvement,
- Construction of drainage and sewage pipe in newly develop separate sewer system area,
- Interceptor and conveyance sewer construction,
- Intermediate wastewater pumping station construction and
- Wastewater treatment plant construction
- Procurement of sewer cleaning equipment

Main alterations are described below.

(a) Location of the wastewater treatment plant site is moved about 2 km nearer to the sewerage development area than the location proposed in FS. The site is located in Binh Hung Ward in Binh Chanh District.
(b) Due to the weak soil condition
(c) of the new treatment plant site, particular supplementary soil improvement works is required.

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(d) Required length of the conveyance sewer is shortened about 2 km. Then the conveyance system is reviewed and proposed the trench method for sewer installation.
(e) The proposed retarding pond for pump drainage improvement in Thanh Da area was developed as a park. And the storage capacity of the pond was reduced. Subsequently, pump capacity was required to enlarge.

14.1.2 Basic Conditions of Cost Estimate

The project cost consists of (A) Construction Cost, (B) Administration Cost, (C) Engineering Cost, (D) Land Acquisition and Compensation Cost, (E) Physical Contingency, and (F) Price Contingency.

The project cost is estimated based on the following basic conditions.

(a) The estimates are made on the assumption that all construction works will be contracted the general contractors through the international bidding.
(b) All base costs are expressed under the economic conditions that are prevailing in May 2000.
(c) Construction cost consists of (i) direct construction cost, (ii) site preparation expense, and (iii) overhead, profit and tax. Direct construction cost is estimated by multiplying the quantity of work and its unit cost.
(d) Construction cost of power supply from the supplier to the facilities is out of the estimation of this cost estimate.
(e) Expenses of site preparation for urban drainage improvement and sewerage development are assumed respectively 15 % and 12 % of direct construction cost including equipment cost.
(f) Overhead, profit and tax for urban drainage improvement and sewerage development are assumed respectively at 10 % and 5 % of direct construction cost including equipment cost.
(g) Compensation cost for relocation is estimated based on the Vietnamese regulations. In this cost estimation, land acquisition cost is included in the compensation cost.
(h) Engineering service is estimated based on the unit rate and required man/month of the engineers.
(i) Administration cost is assumed at 5.0 % of the total cost of construction.
(j) Physical contingency allowance at the rate of 10.0 % of the construction cost and administration cost is assumed.
(k) Currency exchange rate of US$1 = 14,080VND = Y105.0 (May 2000) is applied.
(l) The cost is classified into Foreign Currency (F.C.) and Local Currency (L.C.). F.C. portions include the cost of (i) imported equipment, materials and supplies, (ii) wages of expatriate personnel, and (iii) Overhead and profit of foreign firms. L.C. portions contain (i) domestic materials and supplies, (ii) wages of local personnel, (iii) land acquisition and house compensation, (iv) overhead, profit of local firms, and (v) Taxes.
(m) Annual price escalation rate of F.C. and L.C. portions are assumed at 0.8% and 0.1% until 2006 and 1.2% and 2.5% after 2007 respectively.

14.1.3 Estimated Project Cost

Estimated cost of the project consisting of urban drainage improvement and sewerage development is at 8,625.4 billion VND under the economic condition in May 2000 as given below:

Total Project Cost

(Unit: Billion VND)

Item	F.C.	L.C.	Total
A. Construction Cost			
Urban Drainage Improvement			
(i) Tau Hu – Ben Nghe canal improvement	130.3	304.1	434.4
(ii) Pump drainage improvement	38.5	89.4	127.9
(iii) Existing main combined sewer improvement	38.7	90.3	129.0
(iv) New drainage system development in southern new urban area	44.6	104.0	148.6
(v) Procurement of dredging equipment	92.2	0.0	92.2
Sewerage Development			
(i) Interceptor sewer construction	408.4	277.3	685.7
(ii) Conveyance sewer construction	37.6	82.3	119.9
(iii) Intermediate wastewater pumping station	149.2	122.1	271.3
(iv) Wastewater treatment plant	2,015.5	1,627.4	3,642.9
(v) Sewage collection system in southern new urban area	63.0	51.6	114.6
Sub-Total	3,018.0	2,748.5	5,766.5
B. Administration Cost	0	287.3	287.3
C. Engineering Cost	340.3	119.6	459.9
D. Land Acquisition and Compensation Cost	0	736.9	736.9
E. Physical Contingency	301.8	303.8	605.6
Total of A, B, C, D and E	3,660.1	4,196.1	7,856.2
F. Price Escalation	249.1	520.1	769.2
Grand Total	3,909.2	4,716.2	8,625.4

Note: Customs duties and Value Added Tax are excluded.

The breakdown of the estimated project cost is shown in Table 14.1 and 14.2.

The project is proposed to implement into two (2) phases due to its big amount of project cost.

14.2 Implementation Schedule

14.2.1 Selection of the Sewerage Development Area for Phase I

Sewerage development area is proposed to divide into 24 sub-zones. And 24 sub-zones are classified into four (4) integrated zones from their wastewater collection system. Eastern part of left bank of Ben Nghe canal (East zone) consists of 10 sub–zones of No. 1,2,3,4,5,6,7,8,9 and 10. And Western part of left bank of Tau Hu canal (West zone) consists of six (6) sub-zones of No. 11,12,13,14,15 and 16. Isolated area by both canals of Tau Hu, Ben Nghe and Doi, Te (Isolated zone) consists of five (5) sub-zones of Khanh Hoi, Ong Kieu, Hung Phu, Tung Thien Vuong and Binh Dong. And Southern part of Doi - Te canals (South zone) consists of three (3) sub-zones of Rach Ong, Pham The Hien and Binh Dang, which are locayed in new develop separate sewer system area. Delineation of sewerage sub-zones into

four (4) integrated zones is shown in Fig. 14.1.

Priority sequences for implementation of the priority sewerage development are determined based on the aspects of demand/benefits and constraints of the respective integrated zones.

Demand/benefits consists of population density, public land use and pollution load generation. Constraints consist of affordability of sewerage development, existing combined sewer coverage ratio and obstructions of other projects implementation.

(1) Demand and Benefits of Sewerage Development

1) Population Density

East zone covers a center of Ho Chi Minh City with an area of 828.4 ha consisting of District 1, 3, 5 and 10. The existing and future populations are estimated at 442,070 in 1997 and 425,830 in 2010 respectively. Existing and future population density are 533 person/ha and 514 person/ha respectively.

West zone covers an area of 865 ha with the existing and future population of 517,689 and 505,819. The existing and future population density are estimated at 598 person/ha and 584 person/ha.

The isolated zone covers an area of 561.4 ha with existing and future population of 360,828 and 338,291 respectively. The existing and future population density are at 643 person/ha and 602 person/ha.
The Southern zone covers an area of 536.8 ha with existing and future population of 148,116 and 151,838 respectively, with population density of 276 person/ha and 283 person/ha.

High population density zone has higher priority for sewerage development because of high pollution load generation and relatively worse unsanitary condition, in principle.

The highest score of 4 gives the isolated zone with population density of more 600 person/ha. Next score of 3 gives to West zone and score of 2 gives to East zone. And the lowest score of 1 gives to the South zone.

2) Public Land Use

Ratio of commercial and institutional area to the total sewerage development area is defined as public land use ratio. Higher priority for sewerage development will be given to an integrated zone with high public land use rate

(refer to CHAPTER 2 Table 2.1).

Integrated sub-zone	Public land Use Ratio	Priority Index
East zone	36.1%	4
West zone	12.9%	2
Isolated zone	4.0%	1
South zone	4.0%	1

3) Pollution Load Generation

Sewerage development contributes mitigation of pollution load discharge to the public water bodies. Higher priority will be given to an integrated zone with high pollution load generation.

Integrated sub-zone	Pollution Load Generation (kg/day)		Priority Index
	Existing	Future	
East zone	17,683	21,292	3
West zone	20,708	25,291	4
Isolated zone	14,433	16,915	2
South zone	5,925	7,592	1

(2) Constraints

1) Affordability

Financial viability of the project depends on affordability of the users. Higher priority will be given to an integrated zone with high affordability of the users.

Based on the proposed sewerage tariff system described in Chapter 15, higher sewerage tariff is levied on governmental offices, industrial establishments and commercial enterprises. Hence, the zone with high occupancy rate of these offices and enterprises has high sewerage tariff collection efficiency. Table 14.3 shows sewerage tariff collection efficiency by each district, which is covered by the sewerage development. The integrated zone with high sewerage tariff collection efficiency is defined as the high affordability area for sewerage development.

Sewerage tariff collection efficiency of respective integrated sewerage zone estimated by multiplying sewerage tariff collection efficiency of each district by ratio of area covered by sewerage system to total district area. Table 14.4 shows the point of sewerage tariff collection efficiency of each integrated sewerage zone.

The highest point of 248 is given to East zone with following West zone of 209, Isolated zone of 104 and South zone of 59.

Integrated sub-zone	Tariff Collection Efficiency Point	Priority Index
East zone	248	4
West zone	209	3
Isolated zone	104	2
South zone	59	1

2) Existing Combined Sewer Coverage Ratio

Higher priority will be given an integrated zone with high existing combined sewer coverage rate. Existing combined sewer coverage rate of respective integrated zones is shown below.

Integrated sub-zone	Sewerage Area (ha)	Existing Combined Sewer Coverage Area (ha)	Coverage Ratio (%)	Priority Index
East zone	828.4	828.4	100	4
West zone	865.0	865.0	100	4
Isolated zone	561.5	561.5	100	4
South zone	536.8	195.7	36.5	1

3) Constraint on Other Project Implementation Program

East-West Highway will be constructed along the left bank side of Tau Hu – Ben Nghe canal to connect with National Route 1A in Binh Chang District and Route from Hanoi Highway in District 2 through Thu Thiem tunnel. Interceptor sewer for East zone is proposed to install under Ton Duc Thang, Ham Nghi and Tran Hung Dao roads. Construction of interceptor sewer in East zone can be done independently without any constraint on other project implementation. While, interceptor sewer in West zone is designed along the proposed East-West Highway. If the interceptor sewer is constructed before East-West Highway construction, the interceptor sewer will be damaged by the highway construction. High priority will be given to an integrated zone, which interceptor sewer construction can be done independently without any constraint of other project implementation. The highest score of 4 gives East zone. Next score of 3 gives Isolated zone and score of 2 gives South zone. And the lowest score of 1 gives to the West zone.

(3) Integration of Priority Index

From the integration of above mentioned priority index, East zone gets the highest

priority index of 21, and East zone is proposed to develop in the first phase.

Integrated sub-zone	Priority Index
East zone	21
West zone	17
Isolated zone	16
South zone	7

The construction schedule of East-West Highway is not fixed yet, because the schedule is subject to the completion of relocation program for more than 5,200 houses along Tau Hu-Ben Nghe canal. Hence, the interceptor sewer in West zone is proposed to construct in the second phase. And if the East-West Highway will be constructed in the second phase, the interceptor sewer is proposed to construct simultaneously with East-West Highway. Then West zone is proposed to develop in the second phase together with Isolated zone and South zone.

Each component of the project will be executed in Phase I and Phase II as shown in the following table.

Item	Phase I	Phase II
1.Urban Drainage Development		
(1) Tau Hu -Ben Nghe canal improvement		
Ben Nghe canal	○	-
Tau Hu canal（down stream）	○	-
Tau Hu canal（upper stream）	-	○
(2) Pump drainage improvement		
Thanh Da area	○	-
Ben Me Coc (1) area	○	-
Ben Me Coc (2) area	Sewer/Embankment	○
(3) Existing combined sewer improvement	○	-
(4) New drainage system development in southern new urban area	-	○
(5) Procurement of dredging equipment	○	○
2. Sewerage Development		
(1) Interceptor sewer		
East area	○	-
West area	-	○
Other area	-	○
(2) Conveyance sewer	○	○
(3) Intermediate Wastewater Pumping Station	○	○
(4) Wastewater Treatment Plant	○	○
(5) Sewage collection system in southern new urban area	-	○

14.2.2 Construction Schedule

Construction schedule of the project is prepared based on the following assumption and considerations:

(a) Phase I and II will be executed from 2000 to 2005 and from 2005 to 2010 respectively.
(b) Relocation and resettlement works except Ben Me Coc (2) area will be completed by the middle of 2002.
(c) Rehabilitation of existing combined sewers should be executed in Phase I resulting from its urgency for mitigation of the city inundation.
(d) New storm sewers in Binh Dang, Pham The Hien and Rach Ong areas shall be implemented in Phase II, taking into consideration of existing urbanization condition of these areas.
(e) Canal improvement is usually implemented from the downstream reaches. So, the canal improvement of Ben Nghe and downstream reaches of Tau Hu canal is proposed to implement in Phase I and remaining upstream reaches of Tau Hu canal is proposed to execute in Phase II.
(f) Pump drainage improvement of Thanh Da and eastern part of Ben Me Coc (1) shall be implemented in Phase I, considering the existing urbanization and flood conditions of these areas. Remaining western part of Ben Me Coc (1) and whole area of Ben Me Coc (2) shall be implemented in Phase II.
(g) The construction of interceptor sewer for East area will be implemented in Phase I as mentioned in previous section.
(h) Subsequently, conveyance sewer with a capacity of 192,000 m^3/d shall be implemented in Phase I and additional conveyance sewer with a capacity of 507,000 m^3/d shall be constructed in Phase II.
(i) Intermediate sewage pumping station consisting of civil works, mechanical and electrical works will be constructed into two (2) phases to meet the respective design wastewater volume.
(j) Construction of wastewater treatment plant shall be also executed in two (2) phases to meet the respective design wastewater volume.
(k) Sewage collection system development in Binh Dang, Pham The Hien and Rach Ong areas shall be implemented in Phase II, taking into consideration of existing urbanization of these areas.

Fig. 14.2 shows the proposed construction schedule of the project.

The salient features of Phase I Project are summarized as follows.

Canal Improvement	Ben Nghe Canal Type A : 3,158 m Tau Hu canal Type A : 1,637 m, Type B : 2,439 m

Pump Drainage Improvement	Thanh Da area 15.4 ha Pump capacity = 42 m^3/min. Concrete pile revetment = 75 m Drainage pipe = 680 m (ø 800 - ø 1,200 mm) Ben Me Coc (I) area 70.9 ha Pump capacity = 42 m^3/min. Temporary earth dike = 3,950 m Drainage pipe = 4,620 m (ø 900 - ø 1,800 mm) Ben Me Coc (II) area 46.0 ha Temporary earth dike = 3,300 m Drainage pipe = 4,190 m (ø 600 - ø 2,000 mm)
Existing Combined Sewer Improvement	Additional 6,530 m (ø 1,000 mm - □2,500 mm x 2,000 mm) Replace 3,182 m (□2,000 mm x 2,000 mm, □2,500 mm x 2,500 mm)
Interceptor Sewer	Main 5,548 m (ø 300 mm - ø 1,500 mm) Secondary 7,013 m (ø 300 mm - ø 1,200 mm) Diversion Chamber 32 units
Intermediate Pumping Station	66.7 m^3/min. x 3 units (1 units for stand by)
Conveyance Sewer	ø 1,500 mm x 398 m (shield) ø 2,000 mm x 648 m (shield) □ 1,200 mm x 2,000 mm x 3,070 m (trench)
Wastewater Treatment Plant	Inflow pump 66.7 m^3/min. x 14.5 m x 30 kw x 3 units (1 unit stand by) Primary sedimentation tank 5 m (w) x 13 m (l) x 3 m (d) x 20 units with flight chain type sludge collector Aeration tank 10.5 m (w) x 28 m (l) x 5.5 m (d) x 10 units with blower of 600 m^3/min. x 6.0 mAq x 750 kw x 3 units (1 unit of stand by) Final sedimentation tank 5m (w) x 26 m (l) x 3.5 m (d) x 20 units with flight chain type sludge collector Disinfection tank 5 m (w) x 28 m (l) x 5 m (d) x 4 with sodium chlorine tank of 13 m^2 x 2 units Gravity thickener ø 14 m x 3 m (h) x 1 unit Sludge dewatering Centrifugal type with capacity of 30 m^3/hr. x 3 units (1 unit for stand by) Composting plant Capacity of 106 m^3/day, mixer of 3 m deep with blower of 18 m^3/min. x 4 m (h) x 2 units

Table 14.1 Summary of Total Project Cost (Phase I and Phase II)

(Unit: Million VND)

Item	F.C.	L.C.	Total
A. Construction Cost	3,017,902	2,748,539	5,766,441
A.1 Urban Drainage Improvement	344,223	587,736	931,959
(1) Canal Improvement	130,316	304,067	434,383
(i) Ben Nghe Canal	30,319	70,743	101,062
(ii) Tau Hu (Downstream) Canal	41,037	95,752	136,789
(iii) Tau Hu (Upstream) Canal incld. Ngang 1 -3	58,960	137,572	196,532
(2) Pump Drainage Improvement	38,453	89,409	127,862
(i) Thanh Da	5,321	12,103	17,424
(ii) Ben Me Coc (1)	17,286	40,334	57,620
(iii) Ben Me Coc (2)	15,846	36,972	52,818
(3) Drainage Pipe System Development	83,254	194,260	277,514
(i) Rehabilitation of Existing Combined Sewer	38,679	90,251	128,930
(ii) New Drainage Pipe Installation	44,575	104,009	148,584
(4) Procurement of Dredging Equipment	92,200	0	92,200
A.2 Sewerage Development	2,673,679	2,160,803	4,834,482
(1) Interceptor Sewer	408,365	277,338	685,703
(i) Interceptor Sewer (East)	124,204	84,542	208,746
(ii) Interceptor Sewer (West) and (Others)	284,161	192,796	476,957
(2) Conveyance Sewer	37,600	82,300	119,900
(3) Sewerage Pumping Station	149,222	122,091	271,313
(4) Wastewater Treatment Plant	2,015,450	1,627,495	3,642,945
(5) Sewerage Collection System Development	63,042	51,579	114,621
B. Administration Cost	0	287,307	287,307
C. Engineering Cost	340,273	119,559	459,832
D. Land Acquisition and Compensation	0	736,906	736,906
E. Physical Contingency	301,828	303,789	605,617
Total of A, B, C, D, and E	3,660,103	4,196,100	7,856,203
F. Price Escalation	249,100	520,125	769,225
Total of A, B, C, D, E, and F	3,909,203	4,716,225	8,625,428

Table 14.2 (1/3) Cost Breakdown of Sewerage Development in Phase I and Phase II

(Unit : Million VND)

Item	Quantity	Unit	Unit Cost (1000VND)	Construction Cost	Remark
1. Wastewater Treatment Plant					
1.1 Civil & Building Works					
1.1 Site Preperation					
1) Geotextile Sheet	368,418	m^2	35.0	12,895	
2) Filling Sand	1,859,269	m^3	102.0	189,646	
3) Vertical-Drain	237,906	drain	1,382.0	328,786	
4) Sand mat	184,209	m^3	200.0	36,842	
5) Timber pile	79,800	pile	20.0	1,596	
6) Bagged Soil	7,560	m^3	50.0	378	
1.2 Temporary Access					
1) Temporary Pier	500	m^2	8,676.0	4,338	
2) Temporary Road					
(1) Filling Sand	40,000	m^3	145.0	5,800	
(2) Low Cost Pavement	7,000	m^2	328.0	2,296	
1.3 Receiving Tank (Pumping Pit)					
1) Foundation Pile	104	pile	18,000.0	1,872	
2) Earth Work					
(1)Steel Sheet Pile	2,963	m^2	305.0	904	
(2) Excavation	11,138	m^3	55.8	621	
(3) Surplus Soil	8,154	m^3	48.8	398	
(4) Back Filling	2,984	m^3	34.9	104	
3) Whole Concrete Work					
(Cubic Content of Tank)	7,436	m^3	1,186.0	8,820	
1.4 Primary Sedimentation Tank					
1) Foundation Pile	1,096	pile	18,000.0	19,728	
2) Earth Work					
(1) Steel Sheet Pile	2,443	m^2	305.0	745	
(2) Excavation	70,420	m^3	55.8	3,930	
(3) Surplus Soil	67,631	m^3	48.8	3,300	
(4) Back Filling	2,788	m^3	34.9	97	
3) Whole Concrete Work					
(Cubic Content of Tank)	70,775	m^3	1,186.0	83,938	
1.5 Aeration Tank					
1) Foundation Pile	2,432	pile	18,000.0	43,776	
2) Earth Work					
(1) Steel Sheet Pile	909	m^2	305.0	277	
(2) Excavation	79,461	m^3	55.8	4,433	
(3) Surplus Soil	76,959	m^3	48.8	3,756	
(4) Back Filling	2,502	m^3	34.9	88	
3) Whole Concrete Work					
(Cubic Content of Tank)	143,152	m^3	1,186.0	169,779	
1.6 Secondary Sedimentation Tank					
1) Foundation Pile	4,186	pile	18,000.0	75,348	
2) Earth Work					
(1) Steel Sheet Pile	12,500	m^2	305.0	3,812	
(2) Excavation	199,481	m^3	55.8	11,131	
(3) Surplus Soil	177,317	m^3	48.8	8,653	
(4) Back Filling	22,164	m^3	34.9	774	
3) Whole Concrete Work					
(Cubic Content of Tank)	197,784	m^3	1,186.0	234,572	
1.7 Disinfection Tank					
1) Foundation Pile	170	pile	18,000.0	3,060	
2) Earth Work					
(1) Steel Sheet Pile	2,109	m^3	305.0	643	
(2) Excavation	9,223	m^3	55.8	514	
(3) Surplus Soil	7,092	m^3	48.8	346	
(4) Back Filling	2,131	m^3	34.9	75	
3) Whole Concrete Work					
(Cubic Content of Tank)	7,292	m^3	1,186.0	8,648	
1.8 Sludge Thickner					
1) Foundation Pile	60	pile	18,000.0	1,080	
2) Earth Work					
(1) Excavation	1,590	m^3	55.8	89	
(2) Surplus Soil	693	m^3	48.8	34	
(3) Back Ffilling	897	m^3	34.9	31	

Table 14.2 (2/3) Cost Breakdown of Sewerage Development in Phase I and Phase II

(Unit : Million VND)

Item	Quantity	Unit	Unit Cost (1000VND)	Construction Cost	Remark
3) Whole Concrete Work (Cubic Content of Tank)	2,077	m^3	1,186.0	2,464	
1.9 Out flow waterway & Sand filtration effluent tank					
1) Foundation Pile	76	pile	18,000.0	1,368	
2) Earth Work					
(1) Excavation	2,889	m^3	55.8	161	
(2) Surplus Soil	2,224	m^3	48.8	109	
(3) Back Ffilling	665	m^3	34.9	23	
3) Whole Concrete Work (Cubic Content of Tank)	9,401	m^3	1,186.0	11,150	
1.10 Pipe Gallery					
1) Foundation Pile	476	pile	14,040.0	6,683	
2) Earth Work					
(1) Steel Sheet Pile	6,800	m^3	305.0	2,074	
(2) Excavation	19,875	m^3	55.8	1,109	
(3) Surplus Soil	14,575	m^3	48.8	711	
(4) Back Filling	5,300	m^3	34.9	185	
3) Whole Concrete Work (Cubic Content of Tank)	12,375	m^3	1,186.0	14,677	
1.11 Building					
1) Pumping Station	562	m^2	3,698.0	2,078	
2) Air Blower Room	3,840	m^2	4,814.0	18,486	
	240	pile	18,000.0	4,320	
3) Administrative & Control Room	2,400	m^2	3,698.0	8,875	
	100	pile	18,000.0	1,800	
4) Disinfection Facility Building	448	m^2	4,745.0	2,125	
	56	pile	14,040.0	787	
5) Dewatering Room	5,408	m^2	4,814.0	26,034	
	338	pile	18,000.0	6,084	
6) Compost Plant	12,364	m^2	2,589.0	32,010	
	618	pile	9,720.0	6,006	
1.12 Road in Plant Site	46,550	m^2	500.0	23,275	
1.13 Boundary fence	775	m	209.0	162	
	2,738	m	181.0	496	
1.14 Landscaping works	2	unit	-	3,961	
Total				1,455,166	
Cost for indirect works (12%)				174,620	
Head office expenses (5%)				81,489	
Total of 1.1				1,711,275	
1.2 Mechanical and Electricity Works					
1.2.1 Garbage removal equipment	2	unit	-	2,000	
1.2.2 Grit remooval equipment	2	unit	-	200	
1.2.3 Main pump equipment	2	unit	-	66,500	
1.2.4 Distribution tank equipment	2	unit	-	3,200	
1.2.5 Primary sedimentation equipment	2	unit	-	98,160	
1.2.6 Aeration tank equipment	2	unit	-	123,840	
1.2.7 Final sedimentation tank equipment	2	unit	-	222,180	
1.2.8 Blower equipment (1)	2	unit	-	137,370	
1.2.9 Chlorination equipment	2	unit	-	7,200	
1.2.10 Sand filtration equipment	2	unit	-	24,450	
1.2.11 Gravity type thickened equipment	2	unit	-	5,680	
1.2.12 Cyclone separator type thickened equipment	2	unit	-	62,350	
1.2.13 Sludge storage equipment	2	unit	-	1,850	
1.2.14 Sludge dewatering equipment	2	unit	-	89,100	
1.2.15 Deodorize equipment (1)	2	unit	-	4,250	
1.2.16 Dry and mix equipment	2	unit	-	11,900	
1.2.17 Blower equipment (2)	2	unit	-	450	
1.2.18 Deodorize equipment (2)	2	unit	-	6,450	
1.2.19 Piping material	2	unit	-	111,000	
1.2.20 Spare parts	2	unit	-	27,300	
1.2.21 Packing and Delivery	2	unit	-	42,800	
1.2.22 Main transportation	2	unit	-	36,100	
1.2.23 Installation	2	unit	-	147,600	
1.2.24 Electricity	2	unit	-	699,740	
Above costs include indirect cost and overhead charge.					
Total of 1.2				1,931,670	
Total of 1.				3,642,945	

Table 14.2 (3/3) Cost Breakdown of Sewerage Development in Phase I and Phase II

(Unit : Million VND)

Item	Quantity	Unit	Unit Cost (1000VND)	Construction Cost	Remark
2. Intermediate Wasteater Pumpimg Station					
2.1 Civil & Building Works					
2.1.1 Site Preperation					
1) Geotexitle Sheet	7,134	m^2	35.0	250	
2) Filling Sand	14,268	m^3	145.0	2,069	
2.1.2 Receiving Tank (Pumpig Pit)					
1) Foundation Pile	321	pile	53,320.0	17,115	
2) Earth Work					
(1) Excavation	31,931	m^3	55.8	1,782	
(2) Surplus Soil	19,692	m^3	48.8	960	
(3) Back Filling	12,239	m^3	34.9	427	
(4) Steel Sheey Pile	4,515	m	305.0	1,377	
3) Whole Concrete Work (Cubic Content of Tank)	18,390	m^3	1,186.0	21,810	
2.1.3 Pumping Station Building (Control Room)	2,551	m^2	3,698.0	9,434	
2.4. Road of Site	1,680	m^2	500.0	840	
2.5 Boundary fence	120	m	209.0	25	
	237	m	181.0	43	
2.6 Landscaping works	1	unit	-	580	
Total				56,712	
Cost for indirect works (12%)				6,806	
Head office expenses (5%)				3,176	
Total of 2.1				66,694	
2.2 Mechanical and Electricity Works					
2.2.1 Pump well equipment	2	unit	-	31,633	
2.2.2 Pump room equipment	2	unit	-	64,687	
2.2.3 Grid chamber equipment	2	unit	-	11,188	
2.2.5 Electricity	2	unit	-	63,668	
2.2.6 Installation and Piping	2	unit	-	33,443	
Above costs include indirect cost and overhead charge.					
Total of 2.2				204,619	
Total of 2.				271,313	
3. Interceptor Sewer					
3.1 Interceptor Sewer	-	-	-	583,081	
Sub-Total				583,081	
Cost for indirect works (12%)				69,970	
Head office expenses (5%)				32,652	
Total of 3				685,703	
4. Conveyance Sewer					
4.1. Conveyance Sewer	-	-	-	81,368	
4.2. O/M Road					
1) Undeveloped Area	1,800	m	7,296.0	13,132	
2) Narrow Farm Road	1,400	m	5,326.0	7,456	
Sub-Total				101,956	
Cost for indirect works (12%)				12,235	
Head office expenses (5%)				5,709	
Total of 4				119,900	
5. Sewer Construction Future Development Area					
5.1. New Sewer Construction	-	-	-	56,046	
5.2. Manhole	-	-	-	10,282	
5.3. House Connection	-	-	-	31,139	
Sub-Total				97,467	
Cost for indirect works (12%)				11,696	
Head office expenses (5%)				5,458	
Total of 5				114,621	
Total Construction Cost of Phase I and Phase II				4,834,482	

Table 14.3 Sewerage Tariff Collection Efficiency

HHs/office by type	District									
	Q-1	Q-3	Q-4	Q-5	Q-6	Q-8	Q-10	Q-11	Tan Binh	Total
ewerage Development Area (h	512.1	51.8	354.1	417.1	157.0	744.1	288.9	148.8	117.7	
Estimated Number of HHs, Offices and Institutions in Sewerage Development Area										
Households	51,984	5,788	33,303	51,736	12,688	56,290	15,877	7,457	3,874	
Governmental offices	116	13	51	54	10	50	14	11	2	
Industrial establishments	338	82	463	389	192	510	202	251	117	
Commercial enterprises	908	51	92	316	41	138	91	42	12	
Cultural facilities	12	1	2	2	1	0	1	1	0	
Medical facilities	303	21	69	158	24	57	68	28	10	
Educational facilities	59	8	35	57	9	38	16	7	3	
Density (Number/ha)										
Households	101.51	11.30	65.03	101.03	24.78	109.92	31.00	14.56	7.57	
Governmental offices	0.23	0.03	0.10	0.11	0.02	0.10	0.03	0.02	0.00	
Industrial establishments	0.66	0.16	0.90	0.76	0.37	1.00	0.39	0.49	0.23	
Commercial enterprises	1.77	0.10	0.18	0.62	0.08	0.27	0.18	0.08	0.02	
Cultural facilities	0.0228	0.0013	0.0035	0.0039	0.0018	0.0000	0.0018	0.0012	0.0001	
Medical facilities	0.59	0.04	0.13	0.31	0.05	0.11	0.13	0.06	0.02	
Educational facilities	0.12	0.01	0.07	0.11	0.02	0.07	0.03	0.01	0.01	
Ranking Points										
Households	8	2	6	7	3	9	5	4	1	
Governmental offices	9	3	6	8	2	6	3	5	1	
Industrial establishments	4	1	5	9	6	7	3	8	2	
Commercial enterprises	9	3	5	8	2	7	5	4	1	
Cultural facilities	9	3	7	8	4	1	4	6	2	
Medical facilities	9	2	6	8	3	4	6	4	1	
Educational facilities	9	1	6	8	3	6	4	4	1	
Total points	57	15	41	56	23	40	30	35	9	
Ranking Points Adjusted by Recommended Tariff										
Households	8	2	6	7	3	9	5	4	1	
Governmental offices	16	5	11	15	4	11	5	9	2	
Industrial establishments	7	2	9	16	11	13	5	15	4	
Commercial enterprises	37	12	20	33	8	29	20	16	4	
Cultural facilities	16	5	13	15	7	2	7	11	4	
Medical facilities	16	4	11	15	5	7	11	7	2	
Educational facilities	16	2	11	15	5	11	7	7	2	
Adjusted total points	118	33	81	114	44	81	62	70	18	
Weighted points	118	33	81	114	44	81	62	70	18	

Note : Adjustment factors-

12,500 (VNĐ for households)

51,100 (VNĐ for Commercial enterprises)

22,800 (VNĐ for industrial establishments and others)

Table 14.4 Sewerage Tariff Collection Effciency Indicated by Point

Sub-zone	District									
	Q-1	Q-3	Q-4	Q-5	Q-6	Q-8	Q-10	Q-11	Tan Binh	Total
East zone										
1	30									30
2	32	1								33
3	5									5
4	17									17
5	15	3								19
6	11									11
7	5	28		34			19			87
8	2			16						18
9				16			1			17
10				11						11
Sub-total	118	33	0	78	0	0	20	0	0	248
West zone										
11				6			9			14
12				2						2
13				20			27	8		55
14				7	4		6	36	6	59
15				1	9			25	11	47
16					31					31
Sub-total	0	0	0	36	44	0	42	70	18	209
Isolated zone										
Khanh Hoi			80							80
Ong Kieu			1							1
Hung Phu						8				8
Tung Thien Vuong						9				9
Binh Dong						5				5
Sub-total	0	0	81	0	0	23	0	0	0	104
South zone										
Ranch Ong						15				15
Phan The Hien						21				21
Bing Dang						23				23
Sub-total	0	0	0	0	0	59	0	0	0	59
Total	118	33	81	114	44	81	62	70	18	620

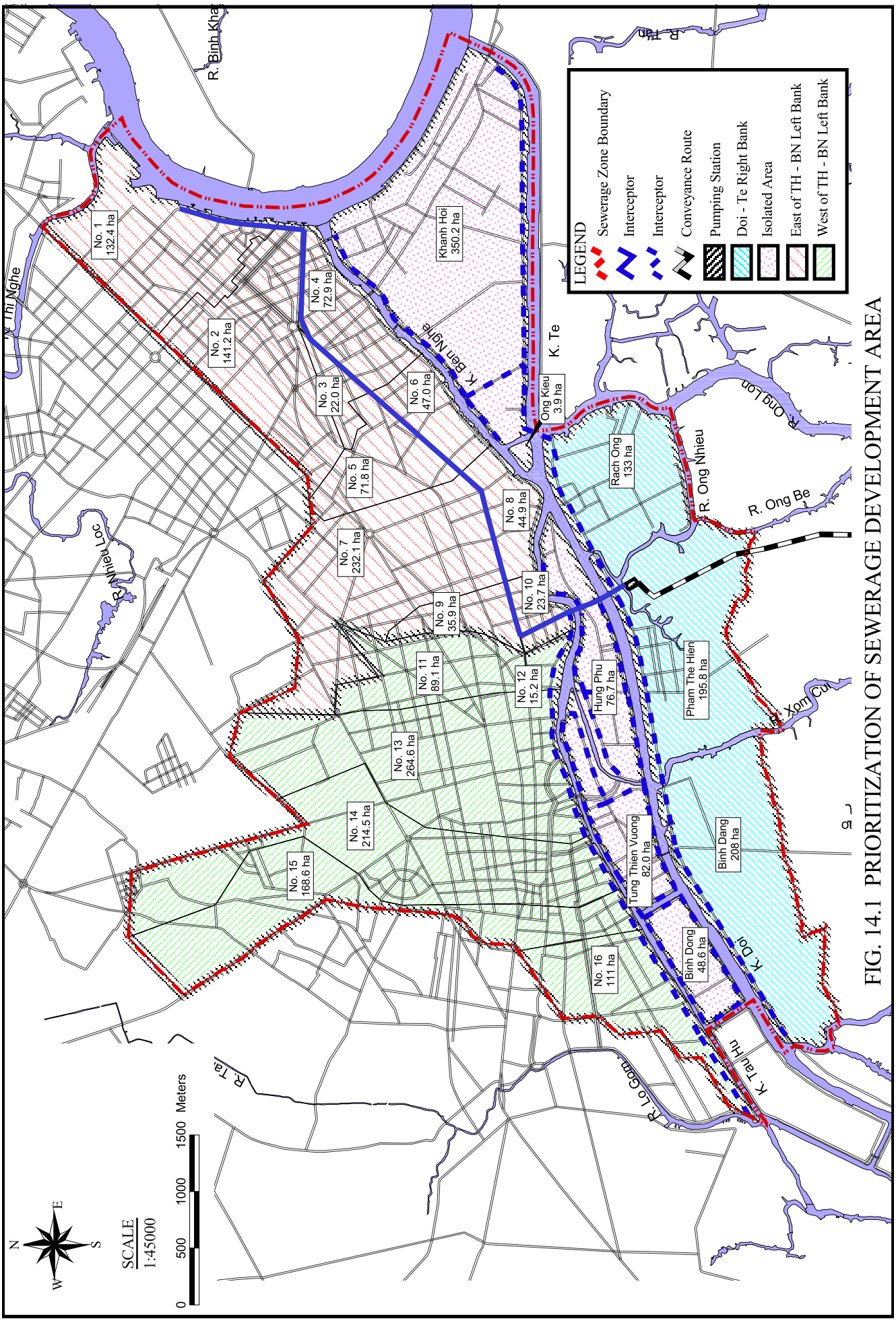
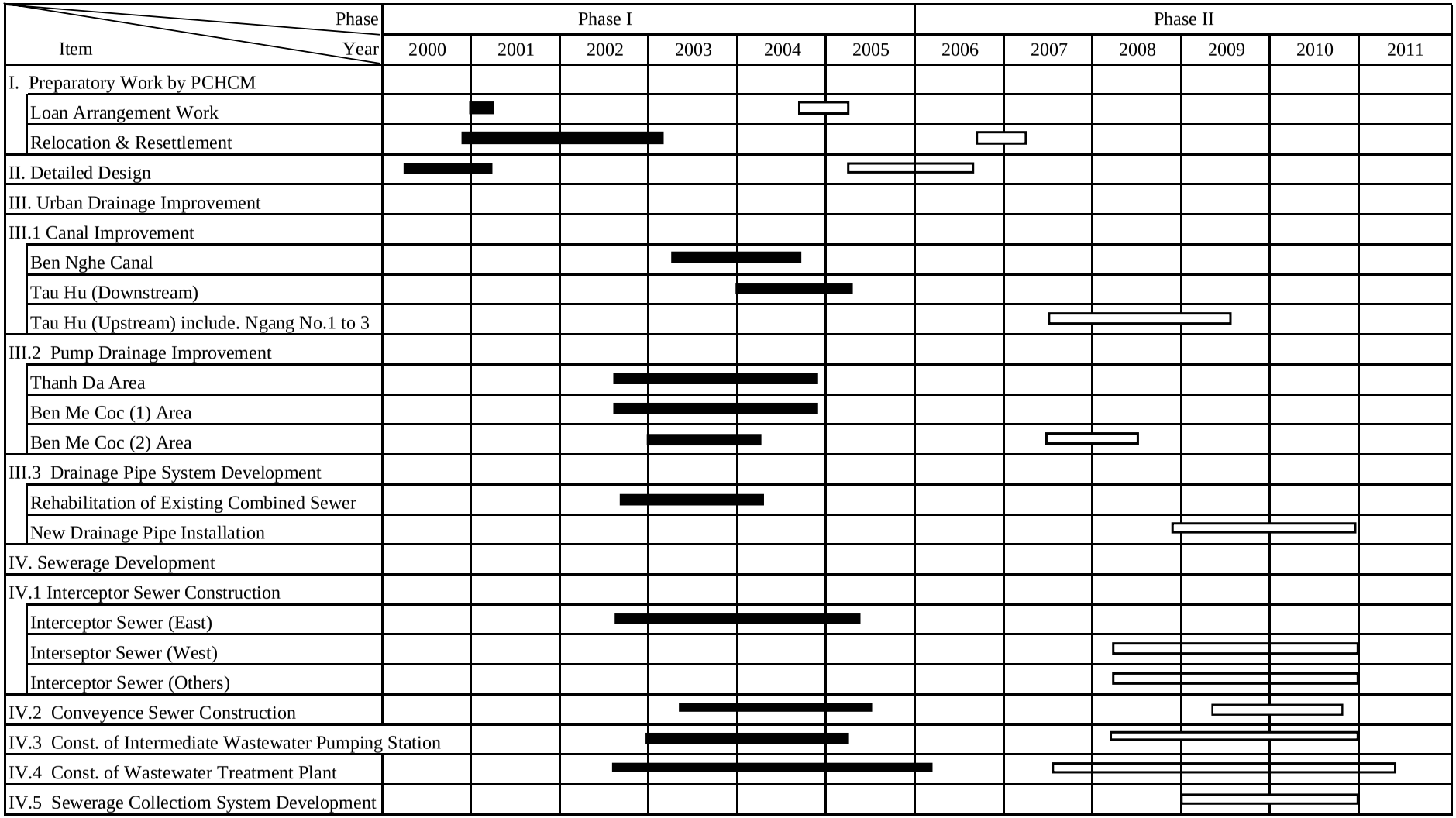


FIG. 14.1 PRIORITIZATION OF SEWERAGE DEVELOPMENT AREA


Phase
Year
Item
Phase I
Phase II
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
I. Preparatory Work by PCHCM
Loan Arrangement Work
Relocation & Resettlement
II. Detailed Design
III. Urban Drainage Improvement
III.1 Canal Improvement
Ben Nghe Canal
Tau Hu (Downstream)
Tau Hu (Upstream) include. Ngang No.1 to 3
III.2 Pump Drainage Improvement
Thanh Da Area
Ben Me Coc (1) Area
Ben Me Coc (2) Area
III.3 Drainage Pipe System Development
Rehabilitation of Existing Combined Sewer
New Drainage Pipe Installation
IV. Sewerage Development
IV.1 Interceptor Sewer Construction
Interceptor Sewer (East)
Interseptor Sewer (West)
Interceptor Sewer (Others)
IV.2 Conveyence Sewer Construction
IV.3 Const. of Intermediate Wastewater Pumping Station
IV.4 Const. of Wastewater Treatment Plant
IV.5 Sewerage Collectiom System Development

Chapter 15

ECONOMY AND FINANCE

CHAPTER 15 ECONOMY AND FINANCE

15.1 Socio-Economy

15.1.1 General

(1) Fiscal Year

Viet Nam uses a fiscal year system as same as calendar year starting 1st of January and ending at 31st of December of the same year. Therefore, annual statistic data expressed in this report are for one year from January to December in the same year.

(2) Currency

Vietnamese domestic Currency is "Dong (herein after expressed as VND = Vietnamese Dong). In this report, the exchange rate of VND 14,500 per US$ 1.00 is applied for economic and financial analyses as a mid rate as of 1st December, 2000 unless otherwise mentioned which is the rate of Japanese yen 110 against US$1.00.

15.1.2 Socio-Economic Features

(1) Gross Regional Domestic Product

In 2000, Gross Regional Domestic Product (GRDP or GDP) of Ho Chi Minh City grew to VND76,659 billion at current price with an average annual growth rate of 12.86% since 1996, while the real annual growth rate at constant price of 1994 was 9.05% in average during the same period as shown in Table 15.1.

A difference between the two average annual growth rates at current market price and at 1994 constant price seems to be caused by rather high increase ratio of price.

Per capita GDP at current market price amounted to VND14,829,000 (equivalent to US$ 1,022.69) in 2000 at the annual growth rate of 10.49% since 1996, and the real growth rate was 6.76% for the same period as also shown in the same Table.

(2) Financial Situation of Ho Chi Minh City

In 2000, the scale of finances of Ho Chi Minh City amounted to VND6,540 billion (equivalent to US$459 million) in revenue and VND5,594 (equivalent to US$393 million) in expenditure with their rise rate of 22% and 20% per annum since 1996 respectively as shown in Table 15.2 and summarized hereunder.

Among the revenue, the category of "others" contribute quite a high rate to the total revenue as 54% in 1996 and 57% in 2000 with increasing ratio of around 20% per

annum, but statistical data issued in Ho Chi Minh City do not make clear its detail.

Finance of Ho Chi Minh City

(VND billion)

Revenue/expenditure	1996	1997	1998	1999	2000	Average annual growth rate (%)
Revenue	2,959	4,449	5,304	5,892	6,540	21.93
Expenditure	2,706	3,906	3,948	4,424	5,594	19.90
Surplus/deficit	253	543	1,356	1,468	946	-

The construction expenditure has grown with a rate of around 42% per annum since 1996 and its shares at 19% in 1996 to 38% in 2000 to the total amount of expenditure. As shown in Fig.15.1, there are several branch offices of the central Government located in Ho Chi Minh City, and they also have own construction budget for developing and repairing the infrastructure in Ho Chi Minh City managed by the central Government like national road. Therefore, whole amount of these two kinds of construction budget is for the total development and repairing the infrastructure located in Ho Chi Min City.

(3) Balance of International Trade

In Vietnam, the Government and the local administration unit manage all international trading businesses. In Ho Chi Minh City, the international trading activities have grown from US$3,473 million in 1996 to US$5,232 million in 2000 with 11% annual growth in export, and from US$3,180 million in 1996 to US$2,625 million in 2000 with -5% of annual increasing ratio in import. Among them, around 70% of export activities are managed by central Government, and 41% of import activities are managed by central Government as shown in Table 15.3 and summarized below.

International Balance of Trade in Ho Chi Minh City

(Million US$)

Export/Import	1996	1997	1998	1999	2000	Average annual growth rate (%)
Export	3,473	3,296	3,037	3,818	5,232	10.79
Import	3,180	3,066	2,633	2,431	2,625	-4.68
Balance of trade	293	230	404	1,387	2,607	-

The said Table shows details of international trading activities. According to this data, industrial products show the highest share rate to the total export as 89% with a sum of US$4,665 million in 2000, while raw material and fuel show the highest share to the total import amount as 80% amounting to US$2,106 in the same year.

(4) Industry

Gross output of whole industries in Ho Chi Minh City has grown from VND45,696 billion in 1996 to VND85,319 in 2000 at current price with growth rate of 17% per annum, and manufacturing activities are top industrial sector with share rate of around 96% to the total gross output of whole industries since 1996 as shown in Table 15.4.

From the viewpoint of type of industrial activities, manufacturing in "foodstuff and beverage" shows the highest output as share rate of 20% to 29% in these years 1996 to 2000.

Number of establishments has decreased with a rate of –2.82% per annum from 31,243 firms in 1996 to 27,865 firms in 2000 as shown in Table 15.5. However, number of employees for these establishments has grown with a rate of 14.37% per annum from 404,252 persons in 1996 to 691,758 persons in 2000. Growth rate of employment is higher than that for the number of establishment. It can be said that the scale of industries was become gradually larger year by year.

Construction categories include a construction works for several kinds of building construction, development of infrastructures and their repairing.

Since 1996, the gross output in construction sector has grown with rate of 11% per annum from VND7,915 billion in 1996 to VND12,176 billion in 2000 as shown in Table 15.6. On the other hand, the output on investigation and design for construction show rather low increasing rate as 6 % comparing with that for the actual construction.

Table 15.7 shows share rates of investment by type of management together with actual outlays for them by type of economic activities. According to this data, Ho Chi Minh City made around 60 % of construction works during the period from 1996 to 2000. And almost of them were spent for industrial facilities as 44 % in 1996, 36 % in 1997, 30 % in 1998, 43 % in 1999 and 51 % in 2000 to the total outlays in each year.

(5) Agriculture

The central Government and the local administrative units manage agricultural activities. Gross output from agricultural production has grown from VND2,083 billion in 1996 to VND2,528 billion with an annual growth rate of 5%. Among them, Ho Chi Minh City as shown in Table 15.8 managed 98 - 99 % to the total output in every year since 1996.

Among the agricultural product, livestock has highest share rate at 25 % in 1996 and 28 % in 2000. Paddy shows the second highest share rate to the total products at 22% in 2000.

Table 15.9 shows cultivated area and production volume. According to this data, productivity of paddy was almost 3 tons per ha during past 5 years since 1996. This

productivity rate is not so much high, but not low considering agro-technical situation in Vietnam.

Among food crops, paddy shared the highest cultivated area with a rate of 98 % in total crops. Among industrial crops, sugar cane shared the highest cultivated area in 2000 with the rate of around 53 % in total industrial crops.

(6) Other Economic Activities

As far as trade and services activities are concerned, total amount of turnover increased from VND34,876 billion in 1998 to VND37,227 billion in 2000 with a increasing rate of 3 % for trade activities and from VND1,741 billion in 1998 to VND2,560 billion in 2000 with an increasing rate of 21 % for services activities respectively, while hotel & restaurant activities show decrease comparing to those of 1998 at a sum from VND4,361 billion to VND4,079 billion with an increasing ratio of -3 % as shown Table 15.10.

The gross output of transportation, storage and telecommunication has grown from VND6,631 billion in 1996 to VND10,854 billion in 2000 with an increasing rate of 13 % per annum as shown in Table 15.11.

15.1.3 Prices

(1) Consumable Prices

The average annual increasing rate of consumer price index was 3.6% since 1996 to 2000. Table 15.12 (A) shows its detail.

(2) Exchange Rate

The monthly fluctuations of exchange rate against US Dollars during the period 1996 to 2000 are shown in Table 15.12(B) and summarized bellow:

Exchange Rate Since 1996
(Average rate of each year)

(VND/US$)

Y Year	1996	1997	1998	1999	2000	Average annual decreasing rate (%)
US$	11,044	11,819	13,453	13,955	14,232	6.55%

15.2 Economic Evaluation of Urban Drainage Improvement

15.2.1 Identification of Economic Benefit

An economic analysis appraises a project under study in terms of national and/or regional social economy by comparing and measuring its economic cost and benefits. In other words, economic analysis evaluates a degree of economic impacts on a project under study that would bring about in the national and/or regional economy.

Damages should be estimated first by damageable items as:

- buildings including residential, commercial, industrial and institutional buildings,
- indoor movables as furniture of residential buildings stored goods or materials of commercial and/or industrial buildings, and office furniture of industrial buildings,
- public facilities,
- agricultural damages in agricultural area,
- business suspension losses for commercial activities due to inundation,
- medical cost (if living environment will be improved by completion of the Project, some of water borne diseases may be controlled and decreased, so that people's burden for medical cost and/or fees will be decreased), and
- navigation benefit as a time saving of waiting for loading and unloading.

Using these damages, the annual average damages should be estimated by using a concept of probability of flood. These annual average damages may become an economic benefit when the Project will be executed because that these damages may be mitigated by the Project.

(1) Direct Damages

Table 15.13 shows unit damages to buildings and indoor movables per ha by district in 1-year flood and 10-years flood in present. Table 15.14 through Table 15.17 shows a calculation process of damages to be converted into economic benefit in the Project area, and summarized below:

Average Annual Damages to Buildings and Indoor Movables to Be Converted into Benefit

(million VN~~Đ~~)

Situation	Amount
In present urbanized situation (at present)	74,008
In future urbanized situation (in 2020)	144,319

Table 15.18 shows a calculation process of damages to public facilities to be converted into economic benefit in the Project area, and summarized below:

Average Annual Damages to Public Facilities to Be Converted into Benefit

(million VN~~Đ~~)

Situation	Amount
In present urbanized situation (at present)	1,143
In future urbanized situation (in 2020)	2,189

Table 15.19 through 15.23 shows a calculation process of damages to paddy to be converted into economic benefit in the Project area, and summarized below:

Average Annual Damages to Paddy to Be Converted into Benefit

(million VN~~Đ~~)

Situation	Amount
In present urbanized situation (at present)	512
In future urbanized situation (in 2020)	256

These direct damages are summarized in Table 15.24

(1) Indirect Damages

Table 15.25 shows the share rate of trading and services in Ho Chi Minh City, and Table 15.26 shows a number of households engaged in trading and services. Using these data, business suspension losses are estimated as shown in Table 15.27 as summarized below:

Average Annual Business Suspension Losses to Be Converted into Benefit

(million VN~~Đ~~)

Situation	Amount
In present urbanized situation (at present)	16,909
In future urbanized situation (in 2020)	15,442

Income losses of workers are also influenced by the similar project. Table 15.28 shows a calculation process of it, and summarized below.

Average Annual Income Losses of Workers to Be Converted into Benefit

(million VN~~Đ~~)

Situation	Amount
In present urbanized situation (at present)	555
In future urbanized situation (in 2020)	1,035

The project is a combined project of improvement of urban drainage system and improvement of sewerage systems in Ho Chi Minh City, so that it may contribute to improve the people's living environment.

If living environment will be improved these kind project, some of water borne disease may be decreased and, people's burden for medical cost of fees, or some amount of budget to use for hospital may be decreased too. Basic data and information on medical affairs are shown in Table 15.29 and the calculation process of saving amount of medical fees are shown in Table 15.30, and summarized below:

Average Annual Saving Amount of Medical Costs to Be Converted into Benefit

(million VN~~Đ~~)

Situation	Amount
In present urbanized situation (at present)	556
In future urbanized situation (in 2020)	1,092

According to an information of "Pre-Feasibility Study on Improvement, Construction and Rehabilitation of Tau Hu - Doi - Te Canals", the average waiting time of ships and/or boats for harboring to load or to unload their goods transported was 7 hours. And existing harboring rate is only 75% caused by shallow riverbed of the canals.

Therefore, a lot of consignors should pay extra fees and/or charges for inland waterway transportation to the firms of ship owners to use ships and/or boats.

By the project, it is planned to excavate the riverbed of Tau Hu-Be Nghe Canal so to improve the discharge capacity of said canals. The depth of excavation is already mentioned in previous Chapter that based on the design criteria.

These saved amounts of inland waterway transportation fees/charges should also be counted as the navigation benefit in this kind of project. The canals belong to the Project area, so this benefit should be added to the indirect benefit of the Project. Table 15.31 shows a calculation process of saving amounts to be converted into economic benefit of the Project, and summarized below:

Average Annual Saving Amount of Navigation to Be Converted into Benefit

(million VN~~Đ~~)

Situation	Amount
In present urbanized situation (at present)	13,060
In future urbanized situation (in 2020)	21,980

Table 15.32 shows a summary of whole indirect benefit, and following Table shows a

summarized result of whole economic benefits in the Project area.

Average Annual Benefit

(million VN~~Đ~~)

Direct benefit			Indirect benefit		
Benefit items	Base year	2020	Benefit items	Base year	2020
Buildings/movables	74,008	144,319	Business suspension losses	16,909	15,442
Public facilities	1,143	2,189	Income losses of workers	555	1,035
Agricultural crops	512	256	Saving amount of medical cost	556	1,092
			Navigation benefit	13,060	21,980
Total	75,663	146,764	Total	31,080	39,549

15.2.2 Identification of Economic Cost

Economic cost of a project is identified as opportunity cost of the project. In this case, if goods and services would be invested in the project under study, they could no longer be utilized for other project. This implies that the benefits of the other project could have been created would be sacrificed. These sacrificed benefits of the other project are called opportunity cost of the project. A project cost consists of foreign currency portion and local currency portion.

Firstly, a gross construction cost is estimated based on unit prices and work volume, and this gross construction cost includes net construction cost, engineering cost for supervision, cost for administration, corporate tax, cost for compensation, physical contingency and price contingency.

(1) Foreign Currency Portion

Using the gross construction cost, an economic cost of Project is estimated. In this study, the net construction cost includes labour cost, cost for materials, and cost for equipment. For the foreign currency portion, these costs for labour, materials and equipment are estimated in either Cost Insurance Freight (CIF) price. These international prices are assumed to reflect economic cost directly.

Corporation tax is not included in the foreign currency portion because that the said tax should be paid by local currency based on the taxation regulation in Vietnam.

For economic evaluation of the Project, such transfer cost as contractor's overhead and profit should be deducted, and price contingency should be excluded because that comparison of cost and benefit is made by net present value.

(2) Local Currency Portion

Because it is presumed that price controls and other regulation distort local market in

developing countries, price in the domestic market do not reflect economic scarcity of goods and services. This means that the prices can not be used to identify economic costs of local procurement and have to be converted into economic prices.

In economic analysis of a project, conversion factors are used to convert the costs in domestic markets into economic cost of a project. In this case, using export and import statistics, a standard conversion factor is estimated at a rate of 0.90499 as shown in Table 15.33. This SCF is converts the domestic commodity price into the economic prices that can be assumed to reflect the economic scarcity of the local equipment and materials.

However, SCF is applied to only tradable goods. The economic cost of non-tradable goods and services has to be separately evaluated. Conversion factors of land, skilled and non-skilled labours are respectively estimated.

Economic wage of unskilled labours to be employed for the construction works is assumed to be 70% of actual market wage, taking of the employment opportunity of laborers in the study area.

Economic cost of land compensation including other compensation cost such as the cost for removal of houses is assumed to be 100% of the financial cost, taking into account of the opportunity cost of land use.

(3) Total Economic Cost

The estimated economic cost are shown in Table 15.34, and summarized below:

Economic Cost for Urban Drainage System Improvement Works

(Billion VN₫)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
1st phase	105.1	99.4	140.0	140.0	140.0	46.5				671.0
2nd phase						18.5	167.4	165.9	86.9	438.7
Total	105.1	99.4	140.0	140.0	140.0	65.0	167.4	165.9	86.9	1,109.7

(4) Economic Costs for operation/maintenance (OM cost)

Financial costs for operation/maintenance (OM cost) at sums of VN₫5.9 billion for 1st phase and VN₫0.2 for 2nd phase both per annum, and replacement cost (cost for R) at sums of VN₫4.2 billion per annum for 1st phase and VN₫3.6 billion per annum for 2nd phase both for reservation are estimated in Table 15.35 as economic cost. This cost for OM will be a burden to the Project until the end of the project life of 50 years after completion of the drainage system improvement works. It is assumed that the replacement works will be made 15, 20 and 40 years' intervals.

15.2.3 Economic Evaluation of Urban Drainage and Sewerage System Improvement

The evaluation of urban drainage system improvement is made using cash flows as shown in Table 15.35, and summarized below:

Results of Economic Evaluation for Drainage System Improvement Works

Net present value(VNĐ10^9)	EIRR (%)	B/C
330.1	15.54	1.43

The EIRR resulted at 15.54% as shown in the Table 15.35. It has cleared the level of 10% of opportunity cost in Vietnam with enough allowance, so it may say that the Project has a viability to be executed.

In the combined case of the Urban Drainage Improvement Works and the Sewerage System Improvement Works, the EIRR and B/C ratio are resulted at –1.05 % 0.33 respectively. This is because that, in combined case, the cost has become double or more, but the benefit is almost the same in monetary term.

It is very difficult to quantify the economical effect of such environmental project as Sewerage System Improvement Works. For the necessity of economical evaluation, the amount of willingness to pay of VNĐ12,000/Month/HH is used which is the amount obtained by JICA's Flood Damage Survey conducted in1998. Such project enhances the environmental qualities along the canals and its surrounding neighbors. Such environmental improvement strengthens the basic living conditions to human life and protects the surrounding ecological resources. But to measure such effect monetarily is a very hard work. The main foreseen benefits will be:

- **Improvement of water environment of the Tau Hu - Ben Nghe, Doi - Te Canal**
  The canal improvement aims to recover the amenity of water environment along the canal. Flowerbeds, some low shrub and canopy tree planting have been designed to develop the landscape along the canal and provide a place of recreation and relaxation for the citizens after completion of the canal improvement. To that end, it is essential to prevent the wastewater discharging into the canal and to improve the water quality of the canal which emanates offensive odour.
- **Improvement of water quality of the Saigon River**
  The Saigon River is an important base of the waterway transportation between Mekong Delta and HCMC. A large number of tourists also use the river as a means of transportation so that the river becomes important tourist attractions. Consequently, it is important to preserve the water quality of the Saigon River for the tourist industry.

- **A contribution to a reduction of waterborne diseases contraction ratio**
  The statistics issued by Department of Health of HCMC shows that the total number of patients was 1.087 million and the total medical cost was 364 billion VND in 1997. The share ratio of the patients suffered by water-borne diseases to the total patients was estimated at about 28 % and therefore the improvement of living environment by sewerage development will contribute reduction of the contraction rate of the water-borne diseases.

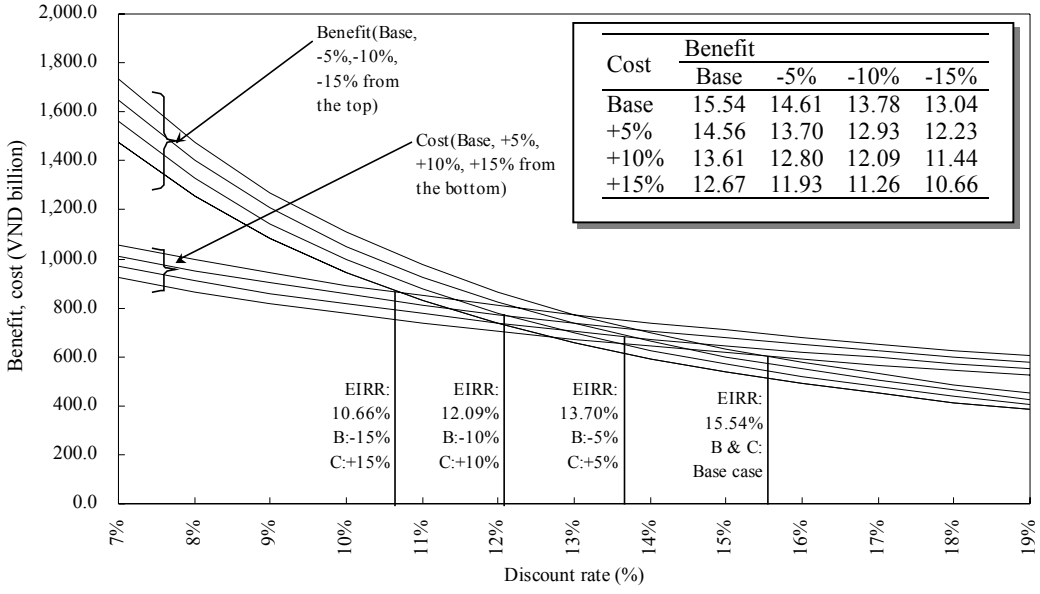
15.2.4 Sensitivity Test for Urban Drainage System Improvement

The economic internal rate of return changes its value depending on the parameters employed for the calculation. Out of these parameters, the construction cost of the Project and its benefit are the most important determinants of the economic analysis.

Therefore, sensitivity test of the economic evaluation of the Urban Drainage Improvement Works is made for 16 combined cases including base case under the benefit of -5%, -10% and -15%, and the cost of +5%, +10% and +15% taking into account of inflation of the benefit and the cost to be likely to come at present economic situation in Vietnam.

A figure and a table hereunder show the result of sensitivity test for economic features.

Sensitivity of EIRR



Cost	Benefit			
	Base	-5%	-10%	-15%
Base	15.54	14.61	13.78	13.04
+5%	14.56	13.70	12.93	12.23
+10%	13.61	12.80	12.09	11.44
+15%	12.67	11.93	11.26	10.66

The EIRR under both the benefit and the cost in base case is calculated as 15.54 % as mentioned above. Under the most pessimistic case of 15 decrease in benefit and 15 % increase in cost, the EIRR is still kept high enough as 10.66 %.

It means that the Drainage System Improvement Works as a component of the Project has a high viability to be executed.

15.3 Financial Analysis

15.3.1 Background and Statutory Conditions for Tariff Setting

In Vietnam, according to the following decrees, the calculation of sewerage charges is set:

(1) Sewerage charges to be collected shall not cover the initial capital investment cost (the Government Decree 90/1998)

(2) Sewerage charges shall be collected as a surcharge of water supply (the Government Decree 03/1999).

(3) For those people who do not use tap water, sewerage charges are collected from those people on the assumption that they use 20 m^3 of tap water per month per H.H. (the Government decree 03/1999).

The first stipulation means that water bill surcharges to be collected only cover operating/maintenance cost and replacement cost of sewerage system. This is that, if money for construction of sewerage systems is needed, the repayment and interest of the loan should be borne by the central or local government. Not only principal or interest, also local funding, such as necessary resettlement cost or local administration cost not being covered by such international loan should be borne by the central or local government.

The second and third stipulations mean that sewerage charges should be collected only through surcharge system. Other way of collecting sewerage charges is not considered by the central Government.

Further to the above, the discussions with PMU (Project Management Unit) being responsible to Ho Chi Minh People's Committee decided the following things:

In parallel to JICA's HCMC Water Environment Improvement Project, there are also two (2) other similar projects being conducting in Ho Chi Minh City. One is that of World Bank's project (HCMC Environmental Sanitation Project) and the other is the Asian Development Bank's project (HCMC Environmental Improvement Project).

Water Bill Surcharges (including those from H.H. using well water) are to be set at the same rate not only covering the three (3) project areas but also covering the 12 urban districts and 5 new urban districts in Ho Chi Minh City. And the amount of surcharge so collected should cover only operating/maintenance and replacement cost s of JICA, World Bank and Asian Development Banks' projects.

The way for collecting such charge from those H.H.using well is to be further studied.

15.3.2 Costs for Operating, Maintenance and Replacement (OM/R Cost)

(1) OM/R Cost for HCMC Water Environment Improvement Project

It is estimated that the OM/R costs for JICA's Urban Drainage Improvement Works are at the sum of 5.9 billion VND per annum for Phase I and 0.2 billion VND per annum for Phase II. And for Sewerage Development works, 34.5 billion VND per annum is estimated for Phase I and 60.0 million VND per annum is for Phase II.

Replacement cost to be collected must be reserved by municipal or central Government for the actual replacement to be taken place in regular intervals. So, the replacement costs of JICA's project are annualized according to replacement intervals. Replacement cost for Urban Drainage Improvement Works are estimated 4.3 billion VND per annum for Phase I and for 4.7 billion VND per annum for Phase II. For Sewerage System Improvement Works, 16.7 million VND per annum are estimated and 27.2 million VND per annum for Phase II.

(2) OM/R Cost for Other Similar Project

In order to calculate the OM/R costs for other similar project, for the World Bank's project, "Feasibility Study and Preliminary Design, Ho Chi Minh City Sewerage Project, Nhieu Loc - Thi Nghe Basin" is referred. And for the Asian Development Bank's project, "Ho Chi Minh City Environment Improvement Project" is referred.

15.3.3 Recommendable Water Bill Surcharge as Tariff for Sewerage Services

(1) Recommended Water Bill Surcharge

In order to calculate the recommendable surcharge rate; following assumptions are taken into account:

(a) The surcharge shall be set at the rate when benefit (water bill charge to be collected from all H.H. in the 12 urbanized areas and 5 new urbanized areas in Ho Chi Minh City) equals to the total OM/R cost of JICA, the World Bank and Asian Development Bank's projects.

(b) In considering the B/C described above, cash discount rate are set at 0%, because when the other discount rate more than 0% is used, positive cash flows in the initial periods set off the negative continuous cash flows thereafter. When such discount rate of more than 0% is used, actual cash flow does not reflect the sound operation of sewerage service.

(c) The ratio of diffusion of tap water is assumed 68% all over the Ho Chi Minh City.

(d) The number of H.H. using tap water in 12 urbanized districts and 5 new urbanized districts are estimated based on population ratio of total Ho Chi Minh City and such

17 districts.

(e) Population increasing ratio is assumed at 1.46% since 1999 to 2010 and at 2.51% since 2010 to 2020 and remains the same thereafter.

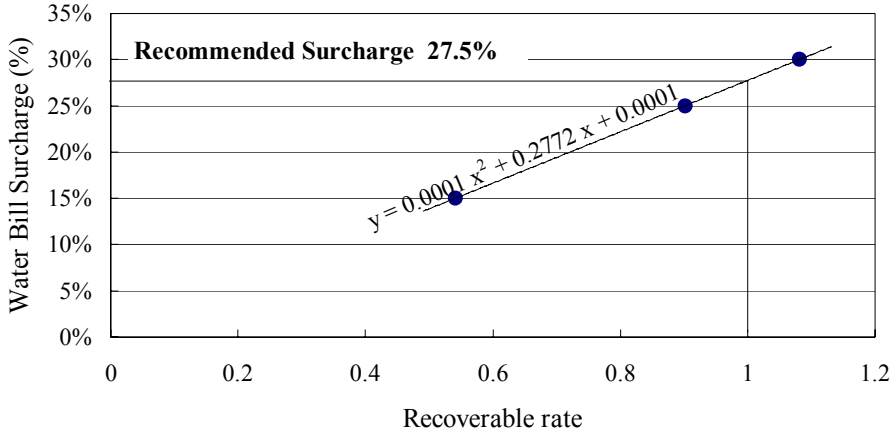
(f) The increasing rate of tap water is assumed 1% per year.

Based on the above assumptions, the recommendable water bill surcharge is calculated.

(2) Suitable Tariff Rate for Sewerage Services in Definitive Plan Stage

In the case of using surcharge rate of 15%, recoverability rate of the total cost of said three (3) projects is 0.5408. If 25% and 30% are applied, the recoverability rates are calculated at 0.9013 and 1.0815 respectively as results of trial calculations

Recommendable Water Bill Surcharge



As indicated in the above figure, the said relationship is expressed as "$y = 0.0001\ x^2 + 0.2772\ x + 0.0001$". If a repayability rate of "1.00"(=100%) is inserted for x, the resulted basic charge "y" is 27.5%. It means that the justifiable surcharge rate is 27.5%. Namely this is a suitable surcharge rate to cover the OM/R cost of three projects.

Table 15.1 shows an envisaged cash flow of OM/R cost derived from the said three (3) projects and expected revenue of charges of sewerage services for checking the suitability of the said surcharge rate. In this case, the amount of charges to be collected is based on the past revenue record of WSC in 1999 applying the said surcharge rate.

In this Table, the amount of surplus in the early years should be reserved for allotting to the deficit appearing after completion of Phase II of JICA's HCMC Water Environment Improvement Project.

According to the results of interview surveys in the Feasibility Study stage, average expenditure for potable water per H.H. ranges from 30,000 VND to 55,000 VND. And, average income of H.H. per month is around 2,000,000 VND. So, a share rate of expenditure for charges for sewerage services will range from 0.42 % to 0.76 % against their monthly income. This seems to be not so heavy burden for the people living in Ho Chi Minh City.

(3) Recommendable Tariff System for Sewerage Services in Definitive Plan Stage

The water tariff system of WSC was up-dated since March 2000. However, revenue record applied as a basic data belongs to the old water tariff system. Therefore, a tariff system for the Sewerage Services for Ho Chi Minh City is tentatively recommended as corresponding to the old water tariff system as follows:

Tentative Tariff System for Sewerage Services in Ho Chi Minh City

Tariff for sewerage services in Ho Chi Minh City is to be collected as surcharge of potable water to be consumed.

Categories		Water Tariff (VND/m^3)	Tariff for Sewerage Services (VND/m^3)
1.	- Water for daily activities in allowance (up to 4m^3 per person)	1,300	360
	- Water for daily activities out of the allowance (over 4m^3 per person)	2,100	580
2.	- Water for production, manufacturing etc.	3,100	860
3.	Water for service business		
	- 8 m^3/month/roll or less	5,200	1,440
	- 9 m^3/month/roll or more	8.700	2,410
4.	Habitants who do not use piped water are to be looked upon as:		
	- minimum water user of 20m^3 per month per household (in case of less than 5 members per household) : Category 4-A		7,210 (/M.H.H.)*
	- minimum water user of 4m^3 per month per person (in case of more than 5 members per household) : Category 4-B		360 (/M.P)**

Remarks:
* : Category 4-A: To be paid monthly per household.
** : Category 4-B : To be paid monthly per person belonging to household, firm, etc.

Table 15.1 Gross Domestic Products (GDP) in Ho Chi Minh City

A. Gross Domestic Product (GDP) (VNĐ.10^9)

Industry of origin	At current price					Annual average growtn ratio(%)	At constant price of 1994					Annual average growtn ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
By Economic Sector:Total	47,243	52,764	61,226	69,001	76,659	12.86	37,380	41,900	45,683	48,498	52,860	9.05
Domestic sector	40,943	44,511	50,587	56,422	62,351	11.09	32,145	35,372	37,772	39,628	43,015	7.55
State	22,581	24,691	27,975	30,925	35,158	11.70	17,894	19,707	21,025	21,914	24,237	7.88
Central state	13,817	14,517	16,821	19,193	22,877	13.43	10,789	11,587	12,657	13,462	15,303	9.13
Local state	8,764	10,174	11,154	11,732	12,281	8.80	7,105	8,120	8,368	8,452	8,934	5.89
Non state	18,362	19,820	22,612	25,497	27,193	10.31	14,251	15,665	16,747	17,714	18,778	7.14
Foreign investment sector	6,300	8,253	10,639	12,579	14,308	22.76	5,235	6,528	7,911	8,870	9,845	17.10
By Economic Activities:Total	47,243	52,764	61,226	69,002	76,660	12.86	37,380	41,899	45,682	48,498	52,860	9.05
Agriculture, forestry and fishery	1,163	1,387	1,459	1,428	1,546	7.38	1,120	1,136	1,100	1,123	1,165	0.99
Agriculture and forestry	981	1,252	1,269	1,289	1,379	8.89	945	967	942	966	999	1.40
Fishery	182	135	190	139	167	-2.13	175	169	158	157	166	-1.31
Industry and construction	19,994	21,629	26,018	30,250	34,497	14.61	14,788	16,885	19,096	20,818	23,370	12.12
Manufacturing	16,506	17,237	20,398	24,743	28,282	14.41	11,973	13,409	14,911	16,743	19,087	12.37
Electricity, gas and water	804	834	1,252	1,348	1,386	14.58	587	635	898	936	959	13.06
Mining	41	54	42	32	39	-1.24	42	44	32	27	29	-8.84
Construction	2,643	3,504	4,326	4,127	4,790	16.03	2,186	2,797	3,255	3,112	3,295	10.80
Services	26,086	29,748	33,749	37,324	40,617	11.71	21,472	23,878	25,486	26,557	28,325	7.17
Trade	8,306	9,148	10,052	10,446	11,274	7.94	6,850	7,300	7,624	7,440	7,752	3.14
Hotels and restaurants	3,859	3,906	4,114	4,517	4,885	6.07	3,108	3,210	3,132	3,218	3,359	1.96
Transport, storage and postal services	3,446	3,908	4,925	6,041	6,567	17.49	2,850	3,134	3,703	4,339	4,645	12.99
Financing and banking	1,456	1,565	1,605	1,709	1,832	5.91	1,203	1,241	1,208	1,221	1,260	1.16
Science technology	169	188	257	309	361	20.89	141	154	194	220	254	15.85
Property business and consulting services	2,632	2,747	3,081	3,024	3,157	4.65	2,184	2,192	2,319	2,142	2,218	0.39
Others	6,218	8,286	9,715	11,278	12,541	19.17	5,136	6,647	7,306	7,977	8,837	14.53
GDP in total	47,243	52,764	61,226	69,001	76,659	12.86	37,380	41,900	45,683	48,498	52,860	9.05
Population(10^3)	4,749	4,853	4,958	5,064	5,169	2.15	4,749	4,853	4,958	5,064	5,169	2.15
GDP per capita (VNĐ.10^3)	9,949	10,873	12,349	13,626	14,829	10.49	7,872	8,635	9,214	9,577	10,225	6.76

B. Share Rate of Gross Domestic Product (% of GDP) (%)

Industry of origin						Annual average growth ratio(%)						Annual average growth ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
By Economic Sector:												
Domestic sector	86.66	84.36	82.62	81.77	81.34	-1.44	86.00	84.42	82.68	81.71	81.38	-1.37
State	47.80	46.80	45.69	44.82	45.86	-1.60	47.87	47.03	46.02	45.19	45.85	-1.07
Central state	29.25	27.51	27.47	27.82	29.84	-1.25	28.86	27.65	27.71	27.76	28.95	0.08
Local state	18.55	19.28	18.22	17.00	16.02	-2.16	19.01	19.38	18.32	17.43	16.90	-2.89
Non state	38.87	37.56	36.93	36.95	35.47	-1.26	38.12	37.39	36.66	36.53	35.52	-1.75
Foreign investment sector	13.34	15.64	17.38	18.23	18.66	8.13	14.00	15.58	17.32	18.29	18.62	7.39
By Economic Activities:												
Agriculture, forestry and fishery	2.46	2.63	2.38	2.07	2.02	-4.25	3.00	2.71	2.41	2.32	2.20	-7.39
Agriculture and forestry	2.08	2.37	2.07	1.87	1.80	-2.61	2.53	2.31	2.06	1.99	1.89	-7.02
Fishery	0.39	0.26	0.31	0.20	0.22	-14.96	0.47	0.40	0.35	0.32	0.31	-9.50
Industry and construction	42.32	40.99	42.50	43.84	45.00	0.89	39.56	40.30	41.80	42.93	44.21	2.82
Manufacturing	34.94	32.67	33.32	35.86	36.89	0.65	32.03	32.00	32.64	34.52	36.11	3.04
Electricity, gas and water	1.70	1.58	2.04	1.95	1.81	3.51	1.57	1.52	1.97	1.93	1.81	3.67
Mining	0.09	0.10	0.07	0.05	0.05	-14.50	0.11	0.11	0.07	0.06	0.05	-16.41
Construction	5.59	6.64	7.07	5.98	6.25	1.68	5.85	6.68	7.13	6.42	6.23	1.61
Services	55.22	56.38	55.12	54.09	52.98	-0.51	57.44	56.99	55.79	54.76	53.58	-1.72
Trade	17.58	17.34	16.42	15.14	14.71	-3.67	18.33	17.42	16.69	15.34	14.67	-5.42
Hotels and restaurants	8.17	7.40	6.72	6.55	6.37	-5.38	8.31	7.66	6.86	6.64	6.35	-6.50
Transport, storage and postal services	7.29	7.41	8.04	8.75	8.57	4.67	7.62	7.48	8.11	8.95	8.79	3.61
Financing and banking	3.08	2.97	2.62	2.48	2.39	-5.32	3.22	2.96	2.64	2.52	2.38	-7.23
Science technology	0.36	0.36	0.42	0.45	0.47	5.78	0.38	0.37	0.42	0.45	0.48	6.24
Property business and consulting services	5.57	5.21	5.03	4.38	4.12	-5.82	5.84	5.23	5.08	4.42	4.20	-7.94
Others	13.16	15.70	15.87	16.34	16.36	5.56	13.74	15.86	15.99	16.45	16.72	5.03
Sub-total	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	

Source : Statistical Yearbook 1999, 2000 Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001.

Table 15.2 Financial Situation of Ho Chi Minh City

A. Amount of Revenue and Expenditure

Item	Amount by fiscal year (million VND)					Annual average growth	Amount by fisical year (thousand US$)					Annual average growth
	1996	1997	1998	1999	2000	ratio(%)	1996(1)	1997(2)	1998(3)	1999(4)	2000(5)	ratio(%)
REVENUE	2,959,128	4,449,263	5,303,730	5,892,308	6,539,501	21.93	267,940	376,450	394,241	422,236	459,493	14.44
Distributed amount from central government	512,434	510,588	564,835	504,410	788,877	11.39	46,399	43,201	41,986	36,145	55,430	4.55
Tax revenue from individual & collective firms	503,567	402,056	398,138	382,268	567,890	3.05	45,596	34,018	29,595	27,393	39,902	-3.28
Tax revenue from foreign investment sector	222,483	212,501	213,640	180,039	338,709	11.08	20,145	17,980	15,880	12,901	23,799	4.26
Revenue from excess of previous year	71,022	360,504	883,699	1,298,140	821,561	84.42	6,431	30,502	65,688	93,023	57,726	73.09
Subsidies from central government	45,126	308,148	141,776	494,849	321,708	63.40	4,086	26,072	10,539	35,460	22,605	53.36
Others	1,604,496	2,655,466	3,101,642	3,032,602	3,700,756	23.24	145,282	224,678	230,554	217,313	260,031	15.67
EXPENDITURE	2,706,713	3,905,744	3,947,756	4,423,659	5,593,821	19.90	245,084	330,463	293,448	316,995	393,045	12.53
Construction expenditure	521,880	996,275	1,174,513	1,206,297	2,142,065	42.34	47,255	84,294	87,305	86,442	150,510	33.59
Frequent expenditure	2,184,833	2,909,469	2,773,243	3,217,362	3,451,756	12.11	197,830	246,169	206,143	230,553	242,535	5.23
Education expenditure	392,848	478,775	651,171	568,700	814,621	20.00	35,571	40,509	48,403	40,752	57,239	12.63
Health expenditure	253,468	513,332	583,458	333,097	977,541	40.14	22,951	43,433	43,370	23,869	68,686	31.53
Administrative expenditure	219,462	276,930	259,604	248,492	247,724	3.07	19,872	23,431	19,297	17,807	17,406	-3.26
Subsidies to wards and communes	102,486	120,913	128,923	133,808	150,333	10.05	9,280	10,230	9,583	9,589	10,563	3.29
Others	1,216,569	1,519,519	1,150,087	1,933,265	1,261,537	0.91	110,157	128,566	85,489	138,536	88,641	-5.29
Balance	252,415	543,519	1,355,974	1,468,649	945,680	39.13	22,855	45,987	100,793	105,242	66,447	30.58

B. Share Rate of Budget (%)

Item	In VND					Annual average growth	In US$					Annual average growth
	1996	1997	1998	1999	2000	ratio(%)	1996	1997	1998	1999	2000	ratio(%)
REVENUE	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Distributed amount from central government	17.32	11.48	10.65	8.56	12.06	-8.64	17.32	11.48	10.65	8.56	12.06	-8.64
Tax revenue from individual & collective firms	17.02	9.04	7.51	6.49	8.68	-15.48	17.02	9.04	7.51	6.49	8.68	-15.48
Tax revenue from foreign investment sector	7.52	4.78	4.03	3.06	5.18	-8.90	7.52	4.78	4.03	3.06	5.18	-8.90
Revenue from excess of previous year	2.40	8.10	16.66	22.03	12.56	51.26	2.40	8.10	16.66	22.03	12.56	51.26
Subsidies from central government	1.52	6.93	2.67	8.40	4.92	34.02	1.52	6.93	2.67	8.40	4.92	34.02
Others	54.22	59.68	58.48	51.47	56.59	1.07	54.22	59.68	58.48	51.47	56.59	1.07
EXPENDITURE	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Construction expenditure	19.28	25.51	29.75	27.27	38.29	18.71	19.28	25.51	29.75	27.27	38.29	18.71
Frequent expenditure	80.72	74.49	70.25	72.73	61.71	-6.49	80.72	74.49	70.25	72.73	61.71	-6.49
Education expenditure	14.51	12.26	16.49	12.86	14.56	0.08	14.51	12.26	16.49	12.86	14.56	0.08
Health expenditure	9.36	13.14	14.78	7.53	17.48	16.88	9.36	13.14	14.78	7.53	17.48	16.88
Administrative expenditure	8.11	7.09	6.58	5.62	4.43	-14.03	8.11	7.09	6.58	5.62	4.43	-14.03
Subsidies to wards and communes	3.79	3.10	3.27	3.02	2.69	-8.21	3.79	3.10	3.27	3.02	2.69	-8.21
Others	44.95	38.90	29.13	43.70	22.55	-15.84	44.95	38.90	29.13	43.70	22.55	

(Note)

(1) Exchange rate in annual average as of 1996: US$ 1.00 = VND 11,044.

(2) Exchange rate in annual average as of 1997: US$ 1.00 = VND 11,819.

(3) Exchange rate in annual average as of 1998: US$ 1.00 = VND 13,453.

(4) Exchange rate in annual average as of 1999: US$ 1.00 = VND 13,955.

(5) Exchange rate in annual average as of 2000: US$ 1.00 = VND 14,232.

Source : Statistical Yearbook 1999and 2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001.

Table 15.3 Export and Import Turnover in Ho Chi Minh City

A. Export Turnover (thousand US$)

Classified:	Amount of turnover					Annual average growth ratio(%)
	1996	1997	1998	1999	2000	
By type of management	3,828,233	3,829,848	3,722,309	4,646,927	6,316,384	13.34
Central Government	2,528,765	2,300,580	2,273,084	3,017,292	4,435,614	15.08
Local Government (Ho Chi Minh City)	944,410	995,228	764,157	800,283	796,701	-4.16
Foreign investment	355,058	534,040	685,068	829,352	1,084,069	32.19
By group of commodities(Excl. foreign investment)	3,473,175	3,295,808	3,037,241	3,817,575	5,232,315	10.79
Agricultural products	1,064,508	460,032	622,141	361,568	323,476	-25.75
Marine products	215,489	209,982	191,317	200,097	203,854	-1.38
Forest products	48,618	61,677	49,484	37,058	39,112	-5.29
Industrial products	2,144,560	2,564,117	2,174,299	3,218,852	4,665,873	21.45
By countries of destination(Excl. foreign investment)	3,473,175	3,295,808	3,037,241	3,817,575	5,232,315	10.79
Laos	2,214	3,914	5,058	3,726	4,923	22.11
Cambodia	12,023	39,137	17,711	18,830	12,609	1.20
Hong Kong	61,977	65,529	40,948	32,586	32,551	-14.87
Singapore	618,385	546,903	397,440	584,983	860,957	8.63
France	56,653	64,141	54,580	72,681	65,017	3.50
Japan	1,042,088	1,010,408	746,392	944,275	1,220,770	4.04
Taiwan	187,514	252,905	208,765	195,161	198,302	1.41
Thailand	44,016	41,971	24,842	10,205	9,086	-32.60
Indonesia	17,150	5,138	99,185	37,864	17,956	1.15
Korea	136,762	99,314	77,343	70,957	69,681	-15.51
Former USSR	19,424	27,087	29,606	44,130	38,843	18.92
Others	1,274,969	1,139,361	1,335,371	1,802,177	2,701,620	20.65

B. Import Turnover

Classified:	Amount of turnover					Annual average growth ratio(%)
	1996	1997	1998	1999	2000	
By type of management	3,851,816	4,095,278	3,620,363	3,415,564	3,843,878	-0.05
Central Government	1,404,001	1,539,356	1,387,112	1,407,336	1,577,989	2.96
Local Government (Ho Chi Minh City)	1,775,975	1,527,132	1,245,781	1,023,448	1,046,789	-12.38
Foreign investment	671,840	1,028,790	987,470	984,780	1,219,100	16.06
By group of commodities(Excl. foreign investment)	3,179,976	3,066,488	2,632,893	2,430,784	2,624,778	-4.68
Spare parts	483,604	549,081	410,474	506,126	359,575	-7.14
Raw materials, fuels	2,305,012	2,204,964	1,885,523	1,735,267	2,105,844	-2.23
Consumable goods	391,360	312,443	336,896	189,391	159,359	-20.12
By countries of origin(Excl. foreign investment)	3,179,976	3,066,488	2,632,893	2,430,784	2,624,778	-4.68
Laos	55,982	3,479	580	1,538	1,320	-60.81
Cambodia	9,168	2,747	1,456	650	1,133	-40.71
Hong Kong	150,429	112,296	95,392	90,513	93,291	-11.26
Singapore	663,773	558,352	524,229	449,865	575,029	-3.52
France	129,623	118,458	137,881	159,520	103,663	-5.43
Japan	359,781	334,844	316,625	218,184	273,693	-6.61
Taiwan	384,944	418,879	370,230	356,814	340,072	-3.05
Thailand	212,857	173,842	160,315	152,834	210,038	-0.33
Indonesia	33,246	45,246	53,238	37,176	33,952	0.53
Korea	537,779	508,533	294,847	324,767	227,297	-19.37
Former USSR	23,023	14,250	8,579	13,358	6,457	-27.23
Others	619,371	775,562	669,521	625,565	758,833	5.21
International Balance of trade of Ho Chi Minh City	-23,583	-265,430	101,946	1,231,363	2,472,506	-353.58

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000, Januasry 2001.

Table 15.4 Gross Output of Industry in Ho Chi Minh City

A. Gross Output by Industry of Origin (billion VNĐ)

Classified by:	At current price					Annual average growth ratio(%)	At 1994 constant price					Annual average growth ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
Economic Sectors	45,696	55,335	68,017	73,706	85,319	16.89	34,719	39,410	44,327	49,560	57,217	13.30
State owned industries	26,378	29,112	31,929	35,467	40,418	11.26	19,138	20,306	22,382	24,345	27,867	9.85
Managed by central government	19,291	21,159	24,554	26,109	29,715	11.41	14,367	15,103	17,163	18,901	21,603	10.74
Managed by local government	7,087	7,952	7,376	9,358	10,703	10.86	4,771	5,203	5,219	5,444	6,264	7.04
Private and/or individual industries	10,617	12,844	15,506	16,286	19,052	15.74	8,834	9,596	10,339	12,112	14,168	12.54
Foreign investment enterprises	8,700	13,379	20,581	21,953	25,849	31.29	6,748	9,508	11,606	13,104	15,181	22.47
Industrial Activities	45,696	55,335	68,017	73,706	85,319	16.89	34,719	39,410	44,327	49,560	57,217	13.30
Mining	101	102	80	75	83	-4.75	70	70	69	53	59	-4.11
Manufacturing	44,056	53,452	65,290	70,764	82,183	16.87	33,493	38,149	42,502	47,700	55,253	13.33
Foodstuff and beverage	13,342	12,939	14,124	15,486	17,065	6.35	10,125	10,334	10,431	11,674	12,778	5.99
Tobacco	2,417	2,561	3,013	3,200	3,789	11.90	2,195	2,282	2,625	2,636	3,148	9.43
Textile products	3,441	4,298	5,071	4,860	5,337	11.60	2,791	3,251	3,456	3,774	4,144	10.39
Garment	3,031	4,461	4,912	5,609	6,459	20.82	1,692	2,525	2,566	2,905	3,275	17.96
Preliminary leather, tanning, production of valises, ba	2,926	5,597	6,437	6,377	6,894	23.89	1,461	2,471	2,738	3,185	3,556	24.91
Wood processing and wood, bamboo products	932	1,015	894	1,061	1,319	9.07	628	633	558	605	763	4.99
Paper and its derivatives	898	1,018	1,275	1,401	1,634	16.15	763	833	930	1,070	1,246	13.05
Publication, printing and photocopying	1,919	1,805	2,093	2,118	2,459	6.40	1,038	1,225	1,339	1,521	1,758	14.08
Coal	1	544	613	698	848	492.53	1	302	331	416	499	434.98
Chemicals and chemical products	3,500	4,235	5,263	6,792	6,792	18.03	3,020	3,286	3,936	4,761	5,562	16.49
Rubber and plastic products	2,467	3,356	4,309	4,882	4,882	18.61	1,970	2,358	2,899	3,369	4,078	19.95
Non-metallic mineral products	2,079	2,496	2,829	2,541	3,225	11.60	1,799	1,881	1,901	1,916	2,454	8.07
Metal	1,674	1,642	1,695	1,842	2,051	5.21	1,492	1,421	1,324	1,449	1,615	2.01
Metal products	1,361	2,005	3,503	3,126	3,526	26.86	1,190	1,544	1,996	2,043	2,329	18.28
Machinery and equipment unclassified	732	989	1,546	1,903	2,484	35.75	572	666	904	1,169	1,528	27.86
Equipment for office automation	-	4	12	352	544	-	-	3	5	32	26	-
Machinery and electric appliances unclassified	379	692	1,295	1,530	2,097	53.43	316	540	1,003	1,185	1,600	50.02
Radios, television sets and communication equipmen	1,120	1,377	2,502	1,890	2,283	19.49	1,023	958	1,520	1,369	1,681	13.22
Medical and optical instruments, clocks of all kinds	144	313	511	318	441	32.26	151	181	178	230	325	21.16
Motor vehicles, trailers	517	669	1,014	1,443	1,854	37.59	411	442	449	665	850	19.90
Other means of transport	551	642	1,043	1,225	1,507	28.62	364	415	580	651	787	21.25
Furniture and other products unclassified	503	664	1,193	1,980	2,322	46.59	384	494	724	970	1,143	31.34
Reproduction	123	131	144	127	131	1.64	108	105	110	104	108	-0.07
Electricity and water supply	1,539	1,781	2,647	2,868	3,053	18.69	1,156	1,191	1,756	1,807	1,904	13.29
Electricity generation and supply	1,266	1,505	2,371	2,584	2,760	21.52	887	921	1,485	1,528	1,616	16.20
Water production and supply	273	276	276	284	293	1.83	270	270	272	279	288	1.66

B. Share Rate of Gross Output by Industry of Origin (%)

Classified by:	At current price					Annual average growth ratio(%)	At 1994 constant price					Annual average growth ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
Economic Sectors	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
State owned industries	57.73	52.61	46.94	48.12	47.37	-4.82	55.12	51.52	50.49	49.12	48.70	-3.05
Managed by central government	42.22	38.24	36.10	35.42	34.83	-4.70	41.38	38.32	38.72	38.14	37.76	-2.27
Managed by local government	15.51	14.37	10.84	12.70	12.54	-5.17	13.74	13.20	11.77	10.98	10.95	-5.52
Private and/or individual industries	23.24	23.21	22.80	22.10	22.33	-0.99	25.44	24.35	23.32	24.44	24.76	-0.68
Foreign investment enterprises	19.04	24.18	30.26	29.78	30.30	12.31	19.43	24.13	26.18	26.44	26.53	8.09
Industrial Activities	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Mining	0.22	0.18	0.12	0.10	0.10	-18.52	0.20	0.18	0.16	0.11	0.10	-15.36
Manufacturing	96.41	96.60	95.99	96.01	96.32	-0.02	96.47	96.80	95.88	96.25	96.57	0.03
Foodstuff and beverage	29.20	23.38	20.77	21.01	20.00	-9.02	29.16	26.22	23.53	23.56	22.33	-6.45
Tobacco	5.29	4.63	4.43	4.34	4.44	-4.27	6.32	5.79	5.92	5.32	5.50	-3.42
Textile products	7.53	7.77	7.46	6.59	6.25	-4.53	8.04	8.25	7.80	7.62	7.24	-2.57
Garment	6.63	8.06	7.22	7.61	7.57	3.36	4.87	6.41	5.79	5.86	5.72	4.11
Preliminary leather, tanning, production of valises, ba	6.40	10.11	9.46	8.65	8.08	5.98	4.21	6.27	6.18	6.43	6.22	10.25
Wood processing and wood, bamboo products	2.04	1.83	1.31	1.44	1.55	-6.69	1.81	1.61	1.26	1.22	1.33	-7.34
Paper and its derivatives	1.97	1.84	1.87	1.90	1.92	-0.63	2.20	2.11	2.10	2.16	2.18	-0.22
Publication, printing and photocopying	4.20	3.26	3.08	2.87	2.88	-8.98	2.99	3.11	3.02	3.07	3.07	0.69
Coal	0.00	0.98	0.90	0.95	0.99	406.89	0.00	0.77	0.75	0.84	0.87	372.17
Chemicals and chemical products	7.66	7.65	7.74	9.21	7.96	0.97	8.70	8.34	8.88	9.61	9.72	2.81
Rubber and plastic products	5.40	6.06	6.33	6.62	5.72	1.47	5.67	5.98	6.54	6.80	7.13	5.87
Non-metallic mineral products	4.55	4.51	4.16	3.45	3.78	-4.53	5.18	4.77	4.29	3.87	4.29	-4.62
Metal	3.66	2.97	2.49	2.50	2.40	-9.99	4.30	3.61	2.99	2.92	2.82	-9.97
Metal products	2.98	3.62	5.15	4.24	4.13	8.52	3.43	3.92	4.50	4.12	4.07	4.40
Machinery and equipment unclassified	1.60	1.79	2.27	2.58	2.91	16.13	1.65	1.69	2.04	2.36	2.67	12.85
Equipment for office automation	-	0.01	0.02	0.48	0.64	-	-	0.01	0.01	0.07	0.05	-
Machinery and electric appliances unclassified	0.83	1.25	1.90	2.08	2.46	31.25	0.91	1.37	2.26	2.39	2.80	32.41
Radios, television sets and communication equipmen	2.45	2.49	3.68	2.56	2.68	2.22	2.95	2.43	3.43	2.76	2.94	-0.07
Medical and optical instruments, clocks of all kinds	0.32	0.57	0.75	0.43	0.52	13.14	0.43	0.46	0.40	0.46	0.57	6.94
Motor vehicles, trailers	1.13	1.21	1.49	1.96	2.17	17.70	1.18	1.12	1.01	1.34	1.49	5.83
Other means of transport	1.20	1.16	1.53	1.66	1.77	10.03	1.05	1.05	1.31	1.31	1.38	7.01
Furniture and other products unclassified	1.10	1.20	1.75	2.69	2.72	25.41	1.11	1.25	1.63	1.96	2.00	15.92
Reproduction	0.27	0.24	0.21	0.17	0.15	-13.05	0.31	0.27	0.25	0.21	0.19	-11.80
Electricity and water supply	3.37	3.22	3.89	3.89	3.58	1.53	3.33	3.02	3.96	3.65	3.33	-0.01
Electricity generation and supply	2.77	2.72	3.49	3.51	3.23	3.95	2.55	2.34	3.35	3.08	2.82	2.56
Water production and supply	0.60	0.50	0.41	0.39	0.34	-12.89	0.78	0.68	0.61	0.56	0.50	-10.28

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001.

Table 15.5 Number of Establishments and Their Employees in Ho Chi Minh City

A. Number of Establishments and Their Employees

Classified by:	Number of establishments					Annual average growtn	Number of employees					Annual average growtn
	1996	1997	1998	1999	2000	ratio(%)	1996	1997	1998	1999	2000	ratio(%)
Economic Sectors	31,243	25,162	24,395	26,590	27,865	-2.82	404,252	430,693	503,641	588,906	691,758	14.37
State owned industries	303	290	285	282	278	-2.13	152,232	154,297	166,692	175,717	168,367	2.55
Managed by central government	122	122	121	124	121	-0.21	97,670	103,769	115,116	122,128	113,208	3.76
Managed by local government	181	168	164	158	157	-3.49	54,562	50,528	51,576	53,589	55,159	0.27
Private and/or individual industries	30,741	24,584	23,791	25,992	27,274	-2.95	206,463	193,762	236,650	299,787	392,313	17.41
Foreign investment enterprises	199	288	319	316	313	11.99	45,557	82,634	100,299	113,402	131,078	30.24
Industrial Activities	31,243	25,162	24,395	26,590	27,865	-2.82	404,252	430,693	503,641	588,906	691,759	14.37
Mining	333	385	691	669	658	18.56	1,249	1,406	2,406	4,311	4,257	35.87
Manufacturing	30,906	24,773	23,700	25,916	27,203	-3.14	393,915	420,590	485,469	568,178	679,829	14.62
Foodstuff and beverage	4,083	3,645	3,339	4,130	3,739	-2.18	47,379	46,295	57,394	57,894	58,357	5.35
Tobacco	10	6	6	8	7	-8.53	4,304	4,410	4,467	4,523	4,430	0.72
Textile products	5,065	2,714	3,775	3,848	3,662	-7.79	50,898	45,158	52,322	59,736	61,778	4.96
Garment	5,674	4,482	2,491	2,816	3,675	-10.29	91,195	101,646	104,860	117,743	135,942	10.50
Preliminary leather, tanning, production of valises, ba	1,169	1,027	935	969	870	-7.12	49,796	64,136	79,561	105,148	175,443	37.00
Wood processing and wood, bamboo products	1,582	1,078	1,160	1,164	1,057	-9.59	15,167	12,087	11,393	19,373	21,998	9.74
Paper and its derivatives	486	461	589	656	677	8.64	6,982	7,804	8,492	11,203	13,427	17.76
Publication, printing and photocopying	468	531	433	441	535	3.40	8,334	8,799	9,746	10,676	11,820	9.13
Coal	5	6	3	12	14	29.36	87	346	407	542	994	83.85
Chemicals and chemical products	629	491	560	615	660	1.21	16,813	16,625	18,598	18,725	22,163	7.15
Rubber and plastic products	2,098	1,878	2,089	2,277	2,719	6.70	22,338	24,374	28,826	37,456	40,374	15.95
Non-metallic mineral products	715	716	571	602	642	-2.66	12,949	12,029	17,781	18,040	19,261	10.44
Metal	512	672	653	665	621	4.94	7,673	7,957	7,321	8,174	7,631	-0.14
Metal products	4,870	4,224	4,305	4,714	5,018	0.75	21,316	22,634	25,659	35,643	34,517	12.81
Machinery and equipment unclassified	735	472	336	359	559	-6.61	8,904	7,126	8,876	10,629	13,102	10.14
Computer and office equipment	-	1	1	3	3	-	-	194	159	244	253	-
Machinery and electric appliances unclassified	408	334	271	294	338	-4.60	4,635	6,223	7,837	10,829	12,475	28.08
Radios, television sets and communication equipmen	117	83	106	117	119	0.42	4,128	5,754	5,856	6,008	5,868	9.19
Medical and optical instruments, clocks of all kinds	48	54	44	50	48	0.00	1,753	2,547	2,606	3,092	4,234	24.66
Motor vehicles, trailers	199	149	198	213	244	5.23	2,925	3,020	5,034	6,168	6,228	20.80
Other means of transport	310	353	483	507	409	7.17	4,961	6,219	7,002	6,558	6,569	7.27
Furniture and other products unclassified	1,440	1,140	1,176	1,276	1,378	-1.09	9,977	14,129	20,461	25,949	22,022	21.89
Reproduction	283	256	176	180	209	-7.30	1,401	1,078	811	885	943	-9.42
Electricity and water supply	4	4	4	5	4	0.00	9,088	8,697	15,766	16,417	7,673	-4.14
Electricity generation and supply	3	3	3	4	3	0.00	7,508	7,639	13,998	14,584	5,798	-6.26
Water production and supply	1	1	1	1	1	0.00	1,580	1,058	1,768	1,833	1,875	4.37

B. Share Rate of Establishments and Employees by Industry of Origin (%)

Classified by:	Establishment					Annual average growth	Employees					Annual average growth
	1996	1997	1998	1999	2000	ratio(%)	1996	1997	1998	1999	2000	ratio(%)
Economic Sectors	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
State owned industries	0.97	1.15	1.17	1.06	1.00	0.71	37.66	35.83	33.10	29.84	24.34	-10.34
Managed by central government	0.39	0.48	0.50	0.47	0.43	2.69	24.16	24.09	22.86	20.74	16.37	-9.28
Managed by local government	0.58	0.67	0.67	0.59	0.56	-0.69	13.50	11.73	10.24	9.10	7.97	-12.33
Private and/or individual industries	98.39	97.70	97.52	97.75	97.88	-0.13	51.07	44.99	46.99	50.91	56.71	2.65
Foreign investment enterprises	0.64	1.14	1.31	1.19	1.12	15.24	11.27	19.19	19.91	19.26	18.95	13.87
Industrial Activities	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Mining	1.07	1.53	2.83	2.52	2.36	22.00	0.31	0.33	0.48	0.73	0.62	18.80
Manufacturing	98.92	98.45	97.15	97.47	97.62	-0.33	97.44	97.65	96.39	96.48	98.28	0.21
Foodstuff and beverage	13.07	14.49	13.69	15.53	13.42	0.66	11.72	10.75	11.40	9.83	8.44	-7.89
Tobacco	0.03	0.02	0.02	0.03	0.03	-5.88	1.06	1.02	0.89	0.77	0.64	-11.93
Textile products	16.21	10.79	15.47	14.47	13.14	-5.11	12.59	10.48	10.39	10.14	8.93	-8.23
Garment	18.16	17.81	10.21	10.59	13.19	-7.69	22.56	23.60	20.82	19.99	19.65	-3.39
Preliminary leather, tanning, production of valises, ba	3.74	4.08	3.83	3.64	3.12	-4.42	12.32	14.89	15.80	17.85	25.36	19.79
Wood processing and wood, bamboo products	5.06	4.28	4.76	4.38	3.79	-6.97	3.75	2.81	2.26	3.29	3.18	-4.05
Paper and its derivatives	1.56	1.83	2.41	2.47	2.43	11.79	1.73	1.81	1.69	1.90	1.94	2.96
Publication, printing and photocopying	1.50	2.11	1.77	1.66	1.92	6.40	2.06	2.04	1.94	1.81	1.71	-4.59
Coal	0.02	0.02	0.01	0.05	0.05	33.11	0.02	0.08	0.08	0.09	0.14	60.75
Chemicals and chemical products	2.01	1.95	2.30	2.31	2.37	4.15	4.16	3.86	3.69	3.18	3.20	-6.31
Rubber and plastic products	6.72	7.46	8.56	8.56	9.76	9.79	5.53	5.66	5.72	6.36	5.84	1.38
Non-metallic mineral products	2.29	2.85	2.34	2.26	2.30	0.17	3.20	2.79	3.53	3.06	2.78	-3.44
Metal	1.64	2.67	2.68	2.50	2.23	7.99	1.90	1.85	1.45	1.39	1.10	-12.69
Metal products	15.59	16.79	17.65	17.73	18.01	3.67	5.27	5.26	5.09	6.05	4.99	-1.37
Machinery and equipment unclassified	2.35	1.88	1.38	1.35	2.01	-3.90	2.20	1.65	1.76	1.80	1.89	-3.70
Computer and office equipment		0.00	0.00	0.01	0.01			0.05	0.03	0.04	0.04	-
Machinery and electric appliances unclassified	1.31	1.33	1.11	1.11	1.21	-1.83	1.15	1.44	1.56	1.84	1.80	11.99
Radios, television sets and communication equipmen	0.37	0.33	0.43	0.44	0.43	3.34	1.02	1.34	1.16	1.02	0.85	-4.53
Medical and optical instruments, clocks of all kinds	0.15	0.21	0.18	0.19	0.17	2.90	0.43	0.59	0.52	0.53	0.61	9.00
Motor vehicles, trailers	0.64	0.59	0.81	0.80	0.88	8.28	0.72	0.70	1.00	1.05	0.90	5.62
Other means of transport	0.99	1.40	1.98	1.91	1.47	10.28	1.23	1.44	1.39	1.11	0.95	-6.21
Furniture and other products unclassified	4.61	4.53	4.82	4.80	4.95	1.78	2.47	3.28	4.06	4.41	3.18	6.57
Reproduction	0.91	1.02	0.72	0.68	0.75	-4.61	0.35	0.25	0.16	0.15	0.14	-20.81
Electricity and water supply	0.01	0.02	0.02	0.02	0.01	2.90	2.25	2.02	3.13	2.79	1.11	-16.19
Electricity generation and supply	0.01	0.01	0.01	0.02	0.01	2.90	1.86	1.77	2.78	2.48	0.84	-18.04
Water production and supply	0.00	0.00	0.00	0.00	0.00	2.90	0.39	0.25	0.35	0.31	0.27	-8.74

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001.

Table 15.6 Gross Outputs of Construction, Investigation and Design, and Gross Outlays for Investment and Repair in Ho Chi Minh City

(million VNĐ)

Classified:	Amount of gross output/outlay					Annual average growth ratio(%)
	1996	1997	1998	1999	2000	
GROSS OUTPUTS						
Construction	7,915,193	9,939,960	11,316,337	11,587,897	12,175,947	11.37
Classified by type of management						
Central government	2,515,648	3,118,549	3,512,775	4,041,435	4,353,639	14.70
Local administrative unit (Ho Chi Minh City	4,792,895	6,011,165	7,034,548	6,865,930	7,170,928	10.60
Foreign investment sector	606,650	810,246	769,014	680,532	651,380	1.79
Classified by economic sector						
From economic activities of the State	3,736,271	4,795,261	5,514,617	6,085,797	6,428,345	14.53
From economic activities in private sector	3,572,272	4,334,453	5,032,706	4,821,568	5,096,222	9.29
From foreign investment sector	606,650	810,246	769,014	680,532	651,380	1.79
Investigation and Design	208,091	231,909	239,430	253,594	259,501	5.67
Classified by type of management						
Central government	158,340	172,187	177,586	183,282	185,141	3.99
Local administrative unit (Ho Chi Minh City	49,751	59,722	61,844	70,312	74,360	10.57
Classified by economic sector						
From economic activities of the State	176,836	185,803	191,962	202,269	206,061	3.90
From economic activities in private sector	31,255	46,106	47,468	51,325	53,440	14.35
OUTLAYS						
Investment and Large Scale Repair						
Classified by source of capital	18,645,022	22,959,860	23,983,565	18,919,668	19,701,058	1.39
Granted state budget	1,486,618	2,349,504	2,414,902	2,122,640	3,183,530	20.97
Central government budget	234,802	321,552	293,946	367,177	400,103	14.25
Budget of local administrative unit	1,251,816	2,027,952	2,120,956	1,755,463	2,783,427	22.11
Investment outlays	922,140	1,500,290	1,700,574	1,557,157	2,581,799	29.35
Large scale repairs	329,676	527,662	420,382	198,306	201,628	-11.57
Credit	193,847	-	-	-	-	
Capital of state owned enterprises	6,685,103	6,328,571	6,518,728	5,179,060	5,645,934	-4.14
Private capital	1,805,348	2,173,229	3,162,150	2,795,821	2,722,434	10.82
Other domestic capital	1,764,016	3,359,962	3,670,611	2,503,366	3,106,805	15.20
Foreign investment capital	6,710,090	8,748,594	8,217,174	6,318,781	5,042,355	-6.89
Classified by Economic Activities	18,645,022	22,959,860	23,983,565	18,919,668	19,701,058	1.39
Agriculture, forestry and fishery	275,877	195,456	173,730	227,687	161,820	-12.49
Industry	8,256,137	8,172,004	7,180,085	8,102,189	10,137,909	5.27
Construction	172,730	238,556	622,462	199,849	205,572	4.45
Trade	40,403	277,658	1,257,901	1,059,842	435,132	81.16
Hotels and restaurants	1,336,036	3,554,628	1,973,261	1,058,900	678,875	-15.57
Transport, storage and telecommunication	3,624,594	3,862,595	3,643,034	1,942,266	2,622,930	-7.77
Science and technology	4,861	7,256	6,398	36,796	71,076	95.55
Property business and consulting services	1,610,948	3,446,356	2,014,970	1,740,182	531,487	-24.21
State management services	42,626	105,854	154,235	102,818	96,644	22.71
Education and training	208,451	269,187	324,138	339,689	542,253	27.00
Public health and social services	389,447	272,993	328,854	213,319	450,543	3.71
Culture and sports	410,410	374,193	510,364	211,917	157,460	-21.30
Personal and public services	2,199,999	2,117,474	5,735,717	3,649,271	3,564,857	12.82
Others	72,503	65,650	58,416	34,943	44,500	-11.49

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January

Table 15.7 Share Rate of Gross Outputs of Construction, Investigation and Design, and Outlays for Investment and Repair in Ho Chi Minh City

Classified:	1996	1997	1998	1999	2000	Annual average growth ratio(%)
GROSS OUTPUTS						
Construction	100.00	100.00	100.00	100.00	100.00	
Classified by type of management						
Central government	31.78	31.37	31.04	34.88	35.76	2.99
Local administrative unit (Ho Chi Minh City	60.55	60.47	62.16	59.25	58.89	-0.69
Foreign investment sector	7.66	8.15	6.80	5.87	5.35	-8.60
Classified by economic sector						
From economic activities of the State	47.20	48.24	48.73	52.52	52.80	2.84
From economic activities in private sector	45.13	43.61	44.47	41.61	41.85	-1.87
From foreign investment sector	7.66	8.15	6.80	5.87	5.35	-8.60
Investigation and Design	100.00	100.00	100.00	100.00	100.00	0.00
Classified by type of management						
Central government	76.09	74.25	74.17	72.27	71.35	-1.60
Local administrative unit (Ho Chi Minh City	23.91	25.75	25.83	27.73	28.65	4.63
Classified by economic sector						
From economic activities of the State	84.98	80.12	80.17	79.76	79.41	-1.68
From economic activities in private sector	15.02	19.88	19.83	20.24	20.59	8.21
OUTLAYS						
Investment and Large Scale Repair						
Classified by source of capital	100.00	100.00	100.00	100.00	100.00	
Granted state budget	7.97	10.23	10.07	11.22	16.16	19.32
Central government budget	1.26	1.40	1.23	1.94	2.03	12.69
Budget of local administrative unit	6.71	8.83	8.84	9.28	14.13	20.44
Investment outlays	4.95	6.53	7.09	8.23	13.10	27.59
Large scale repairs	1.77	2.30	1.75	1.05	1.02	-12.78
Credit	1.04	-	-	-	-	-
State owned enterprises	35.85	27.56	27.18	27.37	28.66	-5.45
Private capital	9.68	9.47	13.18	14.78	13.82	9.30
Other domestic capital	9.46	14.63	15.30	13.23	15.77	13.62
Foreign investment capital	35.99	38.10	34.26	33.40	25.59	-8.17
Classified by Economic Activities	100.00	100.00	100.00	100.00	100.00	
Agriculture, forestry and fishery	1.48	0.85	0.72	1.20	0.82	-13.68
Industry	44.28	35.59	29.94	42.82	51.46	3.83
Construction	0.93	1.04	2.60	1.06	1.04	3.02
Trade	0.22	1.21	5.24	5.60	2.21	78.68
Hotels and restaurants	7.17	15.48	8.23	5.60	3.45	-16.73
Transport, storage and telecommunication	19.44	16.82	15.19	10.27	13.31	-9.03
Science and technology	0.03	0.03	0.03	0.19	0.36	92.87
Property business and consulting services	8.64	15.01	8.40	9.20	2.70	-25.25
State management services	0.23	0.46	0.64	0.54	0.49	21.03
Education and training	1.12	1.17	1.35	1.80	2.75	25.26
Public health and social services	2.09	1.19	1.37	1.13	2.29	2.29
Culture and sports	2.20	1.63	2.13	1.12	0.80	-22.37
Personal and public services	11.80	9.22	23.92	19.29	18.09	11.28
Others	0.39	0.29	0.24	0.18	0.23	-12.70

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2

Table 15.8 Gross Output of Agriculture, Forestry and Fishery in Ho Chi Minh City

A. Gross Output (million VNĐ)

Classified by:	At current price					Annual average growth ratio(%)	At 1994 constant price					Annual average growth ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
Type of Management	2,083,235	2,233,163	2,304,313	2,421,559	2,528,344	4.96	1,801,099	1,830,239	1,760,672	1,814,099	1,879,708	1.07
Central government	4,008	3,129	-	-	-	-	2,739	2,089	-	-	-	-
Local administrative unit (Ho Chi Minh City)	2,058,911	2,201,846	2,249,872	2,378,155	2,480,428	4.77	1,784,478	1,799,371	1,727,853	1,787,224	1,850,065	0.91
Foreign investment sector	20,316	28,188	54,441	43,404	47,916	23.93	13,882	28,779	32,819	26,875	29,643	20.88
Economic Sectors	2,083,235	2,233,163	2,304,313	2,421,559	2,528,344	4.96	1,801,099	1,830,239	1,760,672	1,814,099	1,879,708	1.07
State activities	153,045	138,210	146,592	156,287	199,616	6.87	109,902	94,168	105,018	113,828	141,890	6.59
Private activities	1,909,874	2,066,765	2,103,280	2,221,868	2,280,812	4.54	1,677,315	1,707,292	1,622,835	1,673,396	1,708,175	0.46
Activities in foreign investment sector	20,316	28,188	54,441	43,404	47,916	23.93	13,882	28,779	32,819	26,875	29,643	20.88
Kind of Agricultural Products												
Agriculture	1,737,844	1,863,020	1,933,271	2,033,864	2,125,720	5.17	1,449,602	1,486,258	1,442,425	1,483,588	1,523,670	1.25
a. Cultivation	879,312	992,275	979,191	992,437	1,019,028	3.76	877,975	909,824	832,239	848,727	849,158	-0.83
Paddy	320,386	381,629	370,939	433,432	459,356	9.43	314,074	358,878	294,578	343,914	363,702	3.74
Other food crops	6,980	10,886	7,946	10,353	12,002	14.51	6,784	7,811	5,947	7,363	10,546	11.66
Industrial crops	165,797	163,388	170,950	128,552	122,847	-7.22	168,444	155,765	155,157	127,183	114,870	-9.13
Fruit crops	68,747	82,841	94,482	110,157	107,679	11.87	94,886	104,619	123,478	139,083	137,621	9.74
Vegetables, beans, flowers, and condiment crops	297,111	317,400	298,369	278,879	279,381	-1.53	275,151	248,804	219,516	201,420	192,668	-8.52
Others	20,291	36,131	36,505	31,064	37,763	16.80	18,636	33,947	33,563	29,764	29,751	12.41
b. Animal husbandry	660,682	653,110	725,580	808,357	864,292	6.95	420,498	420,167	446,106	467,499	500,473	4.45
Livestock	440,353	444,044	478,035	559,078	589,939	7.58	270,247	281,991	287,864	307,740	324,232	4.66
Poultry	208,450	195,679	233,924	236,988	259,618	5.64	139,344	128,629	147,983	150,330	164,230	4.19
Others	11,879	13,387	13,621	12,291	14,735	5.53	10,907	9,547	10,259	9,429	12,011	2.44
c. Agricultural services	197,850	217,635	228,500	233,070	242,400	5.21	151,129	156,267	164,080	167,362	174,039	3.59
Forestry	85,546	92,497	95,534	78,542	100,589	4.13	41,910	43,332	42,964	34,361	45,492	2.07
Forestation	1,466	1,263	750	835	720	-16.29	-	-	-	-	-	-
Exploitation of forest products	82,234	88,773	92,449	75,372	97,699	4.40	-	-	-	-	-	-
Others	1,846	2,461	2,335	2,335	2,170	4.13	-	-	-	-	-	-
Fishery	259,845	277,646	275,508	309,153	302,035	3.83	309,587	300,649	275,283	296,150	310,546	0.08
Culture of aqua-products	64,378	55,541	75,937	70,849	87,005	7.82	125,642	110,130	106,141	91,209	129,048	0.67
Fishing	180,356	196,325	171,443	210,259	188,840	1.16	179,734	183,349	161,302	197,129	174,223	-0.78
Fishery services	15,111	25,780	28,128	28,045	26,190	14.74	4,211	7,170	7,840	7,812	7,275	14.65

B. Share Rate of Agricultural Products (%)

Classified by:	At current price					Annual average growth ratio(%)	At 1994 constant price					Annual average growth ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
Type of Management	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Central government	0.19	0.14	-	-	-	-	0.15	0.11	-	-		-
Local administrative unit (Ho Chi Minh City)	98.83	98.60	97.64	98.21	98.10	-0.18	99.08	98.31	98.14	98.52	98.42	-0.17
Foreign investment sector	0.98	1.26	2.36	1.79	1.90	18.07	0.77	1.57	1.86	1.48	1.58	19.60
Economic Sectors	100.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	
State activities	7.35	6.19	6.36	6.45	7.90	1.82	6.10	5.15	5.96	6.27	7.55	5.46
Private activities	91.68	92.55	91.28	91.75	90.21	-0.40	93.13	93.28	92.17	92.24	90.87	-0.61
Activities in foreign investment sector	0.98	1.26	2.36	1.79	1.90	18.07	0.77	1.57	1.86	1.48	1.58	19.60
Kind of Agricultural Products												
Agriculture	100.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	
a. Cultivation	50.60	53.26	50.65	48.80	47.94	-1.34	60.57	61.22	57.70	57.21	55.73	-2.06
Paddy	18.44	20.48	19.19	21.31	21.61	4.05	21.67	24.15	20.42	23.18	23.87	2.45
Other food crops	0.40	0.58	0.41	0.51	0.56	8.89	0.47	0.53	0.41	0.50	0.69	10.28
Industrial crops	9.54	8.77	8.84	6.32	5.78	-11.78	11.62	10.48	10.76	8.57	7.54	-10.25
Fruit crops	3.96	4.45	4.89	5.42	5.07	6.38	6.55	7.04	8.56	9.37	9.03	8.38
Vegetables, beans, flowers, and condiment crops	17.10	17.04	15.43	13.71	13.14	-6.36	18.98	16.74	15.22	13.58	12.64	-9.66
Others	1.17	1.94	1.89	1.53	1.78	11.06	1.29	2.28	2.33	2.01	1.95	11.01
b. Animal husbandry	38.02	35.06	37.53	39.74	40.66	1.69	29.01	28.27	30.93	31.51	32.85	3.16
Livestock	25.34	23.83	24.73	27.49	27.75	2.30	18.64	18.97	19.96	20.74	21.28	3.36
Poultry	11.99	10.50	12.10	11.65	12.21	0.45	9.61	8.65	10.26	10.13	10.78	2.90
Others	0.68	0.72	0.70	0.60	0.69	0.35	0.75	0.64	0.71	0.64	0.79	1.17
c. Agricultural services	11.38	11.68	11.82	11.46	11.40	0.04	10.43	10.51	11.38	11.28	11.42	2.31
Forestry	100.00	100.00	100.00	100.00	100.00	0.00	-	-	-	-	2.99	-
Forestation	1.71	1.37	0.79	1.06	0.72	-19.61	-	-	-	-	-	-
Exploitation of forest products	96.13	95.97	96.77	95.96	97.13	0.26	-	-	-	-	-	-
Others	2.16	2.66	2.44	2.97	2.16	-0.01	-	-	-	-	-	-
Fishery	100.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	
Culture of aqua-products	24.78	20.00	27.56	22.92	28.81	3.84	40.58	36.63	38.56	30.80	41.56	0.59
Fishing	69.41	70.71	62.23	68.01	62.52	-2.58	58.06	60.98	58.59	66.56	56.10	-0.85
Fishery services	5.82	9.29	10.21	9.07	8.67	10.50	1.36	2.38	2.85	2.64	2.34	14.56

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001.

Table 15.9 Cultivated Area and Their Agricultural Production in Ho Chi Minh City

A. Cultivated Area, Production, and Unit Production per Unit Area

Classified by:	Cultivated area (ha)					Annual average growth	Gross production					Annual average growth	Unit production per unit area (ton/ha)				
	1996	1997	1998	1999	2000	ratio(%)	1996	1997	1998	1999	2000	ratio(%)	1996	1997	1998	1999	2000
Economic Sectors	107,020	101,957	97,328	99,132	95,799	-2.73											
State activities	2,362	2,194	2,210	2,449	2,379	0.18											
Private activities	104,658	99,763	95,118	96,683	93,420	-2.80											
Kind of Agricultural Products																	
Food Crops	81,886	78,537	74,844	79,319	77,486	-1.37	214,301	243,876	198,704	232,602	246,982	3.61	2.6	3.1	2.7	2.9	3.2
Paddy	80,327	76,914	73,603	77,749	75,825	-1.43	204,759	235,166	192,652	225,543	239,135	3.96	2.5	3.1	2.6	2.9	3.2
Maize	705	934	790	1,105	1,132	12.57	1,474	2,598	2,159	3,160	3,386	23.11	2.1	2.8	2.7	2.9	3.0
Cassava	434	351	220	230	243	-13.50	4,551	3,158	1,721	1,754	1,859	-20.05	10.5	9.0	7.8	7.6	7.7
Sweet potatoe	242	167	92	120	151	-11.12	2,027	1,458	780	999	1,254	-11.31	8.4	8.7	8.5	8.3	8.3
Others	178	171	139	115	135	-6.68	1,490	1,496	1,392	1,146	1,348	-2.47	8.4	8.7	10.0	10.0	10.0
Vegetables/Beans	12,510	12,233	11,124	10,187	9,340	-7.05	268,951	245,103	212,481	184,201	171,577	-10.63	21.5	20.0	19.1	18.1	18.4
Vegetables	12,171	11,940	10,901	9,929	9,181	-6.81	268,764	244,945	212,352	184,045	171,487	-10.63	22.1	20.5	19.5	18.5	18.7
Beans	339	293	223	258	159	-17.24	187	158	129	156	90	-16.71	0.6	0.5	0.6	0.6	0.6
Industrial Crops	12,073	10,275	10,119	8,136	7,423	-11.45	209,315	219,462	223,954	221,732	169,473	-5.14	17.3	21.4	22.1	27.3	22.8
Peanuts	6,010	5,238	5,313	3,235	3,150	-14.91	12,601	10,683	11,536	5,653	5,860	-17.42	2.1	2.0	2.2	1.7	1.9
Tobacco	481	194	188	243	209	-18.81	859	351	300	419	369	-19.04	1.8	1.8	1.6	1.7	1.8
Sugar cane	5,416	4,693	4,469	4,456	3,904	-7.86	195,855	208,428	212,118	215,660	163,244	-4.45	36.2	44.4	47.5	48.4	41.8
Others	166	150	149	202	160	-0.92	-	-	-	-	-	-	-	-	-	-	-
Other Crops	551	912	1,241	1,490	1,550	29.51	41,910	39,859	-	-	-	-	76.1	43.7	-	-	-
Feeds	252	168	173	149	169	-9.51	-	-	-	-	-	-	-	-	-	-	-
Others	299	744	1,068	1,341	1,381	46.60	-	-	-	-	-	-	-	-	-	-	-

B. Share Rate of Cultivated Area and Their Production (%)

Classified by:	Cultivated area					Annual average growth	Gross production					Annual average growth
	1996	1997	1998	1999	2000	ratio(%)	1996	1997	1998	1999	2000	ratio(%)
Economic Sectors	100.00	100.00	100.00	100.00	100.00							
State activities	2.21	2.15	2.27	2.47	2.48	2.99						
Private activities	97.79	97.85	97.73	97.53	97.52	-0.07						
Kind of Agricultural Products												
Food Crops	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Paddy	98.10	97.93	98.34	98.02	97.86	-0.06	95.55	96.43	96.95	96.97	96.82	0.33
Maize	0.86	1.19	1.06	1.39	1.46	14.13	0.69	1.07	1.09	1.36	1.37	18.82
Cassava	0.53	0.45	0.29	0.29	0.31	-12.29	2.12	1.29	0.87	0.75	0.75	-22.84
Sweet potatoe	0.30	0.21	0.12	0.15	0.19	-9.89	0.95	0.60	0.39	0.43	0.51	-14.40
Others	0.22	0.22	0.19	0.14	0.17	-5.38	0.70	0.61	0.70	0.49	0.55	-5.87
Vegetables/Beans	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Vegetables	97.29	97.60	98.00	97.47	98.30	0.26	99.93	99.94	99.94	99.92	99.95	0.00
Beans	2.71	2.40	2.00	2.53	1.70	-10.97	0.07	0.06	0.06	0.08	0.05	-6.80
Industrial Crops	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Peanuts	49.78	50.98	52.51	39.76	42.44	-3.91	6.02	4.87	5.15	2.55	3.46	-12.94
Tobacco	3.98	1.89	1.86	2.99	2.82	-8.31	0.41	0.16	0.13	0.19	0.22	-14.65
Sugar cane	44.86	45.67	44.16	54.77	52.59	4.06	93.57	94.97	94.71	97.26	96.32	0.73
Others	1.37	1.46	1.47	2.48	2.16	11.90	-	-	-	-	-	-
Other Crops	100.00	100.00	100.00	100.00	100.00		-	-	-	-	-	-
Feeds	45.74	18.42	13.94	10.00	10.90	-30.12	-	-	-	-	-	-
Other econom	54.26	81.58	86.06	90.00	89.10	13.20	-	-	-	-	-	-

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001.

Table 15.10 Private Trade and Services by Economic Sector

	Number of HH engaged (HH)			Number of labourers (persons)			Amount of capital (VNĐ 10^6)			Amount of turnover (VNĐ 10^6)			Average turn-over per labour (VNĐ 10^3)			Monthly average income/labour (VNĐ 10^3)		
	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000
Trade	84,766	83,832	87,293	161,960	163,560	158,303	1,121,937	1,111,789	2,005,957	34,876,008	34,039,465	37,226,911	215,337	208,116	235,162	867	873	1,390
Sales and maintenance of motor vehicles	2,624	2,357	2,747	6,201	7,789	7,669	25,454	47,837	57,079	411,154	749,348	925,213	66,304	96,206	120,643	1,076	1,054	1,293
Sales and maintenance of motor vehicles	30	-	32	126	-	90	282	-	773	11,160	-	11,037	88,571	-	122,633	1,014	-	1,828
Sales of spare-parts and accessories	449	671	817	1,115	1,563	1,971	15,270	29,584	18,465	104,901	173,534	259,343	94,082	111,026	131,579	1,389	1,394	1,293
Sales of motors	2,098	1,626	1,835	4,795	5,962	5,356	8,692	16,057	29,084	267,948	527,644	572,303	55,881	88,501	106,853	1,169	1,039	1,237
Retail sales of fuel	47	60	63	165	264	252	1,210	2,196	8,757	27,145	48,171	82,530	164,515	182,466	327,500	774	807	1,032
Wholesales and agencies (Excl.motor vehicles)	4,690	3,759	3,975	13,833	11,637	11,769	176,109	162,750	245,095	4,936,222	4,803,378	7,742,986	356,844	412,768	657,914	708	705	1,616
Agency, intermediate	170	-	245	383	-	1,029	2,359	-	1,544	85,170	-	63,539	222,376	-	61,748	1,022	-	1,496
Wholesales of agro-forestry products, food stuff	1,405	1,231	1,118	4,777	4,185	3,252	50,159	52,933	31,639	1,669,140	1,610,148	2,061,001	349,412	384,743	633,764	929	953	1,538
Wholesales of personal and family goods	1,995	1,806	1,836	5,903	5,333	4,952	99,304	85,939	142,176	2,414,657	2,467,067	4,316,697	409,056	462,604	871,708	700	720	1,665
Wholesales of non-agricultural raw materials	720	473	502	1,872	1,419	1,632	12,960	14,190	53,965	494,208	491,925	898,329	264,000	346,670	550,447	529	512	1,940
Wholesales of machinery and equipment	309	179	185	680	537	601	8,961	8,055	10,342	212,987	179,358	292,241	313,216	334,000	486,258	552	533	1,386
Others	91	70	89	218	163	303	2,366	1,633	5,429	60,060	54,880	111,179	275,505	336,687	366,927	527	557	1,524
Retail sales (Excl. motor vehicles)	77,452	77,716	80,571	141,926	144,134	138,865	920,374	901,202	1,703,783	29,528,632	28,486,739	28,558,712	208,057	197,641	205,658	872	870	1,356
Retail sales (non special trade)	13,742	13,347	12,939	18,385	16,697	19,217	72,161	53,061	215,679	3,252,941	2,759,999	2,203,937	176,935	165,299	114,687	854	951	1,086
Retail sales of food, foodstuff,cigarette & beverage	25,936	26,006	28,508	36,717	39,567	39,157	125,847	160,766	233,789	5,637,280	6,563,264	5,960,705	153,533	165,877	152,226	753	758	1,213
Retail sales of non foodstuff, cigarette &beverage (special trade)	36,307	36,763	37,503	84,407	85,470	74,303	708,102	675,371	1,217,154	20,303,028	18,907,971	19,945,413	240,537	221,223	268,433	895	876	1,534
Retail sales of old things	309	246	354	515	369	637	4,223	3,014	3,434	40,566	29,609	69,497	78,769	80,241	109,100	1,339	1,449	1,047
Retail sales of outside the stores	1,158	1,354	1,267	1,902	2,031	5,551	10,041	8,990	33,727	294,817	225,896	379,160	155,004	111,224	68,305	910	765	651
Services	16,766	17,503	18,146	35,367	39,243	54,922	187,879	219,204	424,386	1,741,000	2,992,744	2,560,403	49,227	76,262	46,619	1,049	1,093	1,200
Repairs of consumer good	3,275	3,234	3,023	7,528	7,461	8,254	13,829	14,419	43,484	252,794	261,342	276,824	33,580	35,028	33,538	904	954	1,091
Services for individual and family	13,491	14,269	15,123	27,839	31,782	46,668	174,050	204,785	380,902	1,488,206	2,731,402	2,283,579	53,458	85,942	48,932	1,172	1,192	1,251
Hotel &restaurant	24,838	24,834	25,034	55,019	57,714	70,785	214,003	315,821	358,906	4,361,398	4,966,692	4,078,757	79,271	86,057	57,622	1,109	1,176	997
Hotels & lodging houses	729	1,060	1,008	1,677	2,602	2,419	120,759	217,444	149,913	68,322	111,122	72,160	40,741	42,706	29,831	1,344	1,338	1,151
Restaurant, bar and canteen	24,109	23,774	24,026	53,342	55,112	68,366	93,244	98,377	208,993	4,293,076	4,855,570	4,006,597	80,482	88,104	58,605	1,083	1,153	987
Total	126,370	126,169	130,473	252,346	260,517	284,010	1,523,819	1,646,814	2,789,249	40,978,406	41,998,901	43,866,071	162,390	161,214	154,453	1,008	1,047	1,283

Source :

Statistical Yearbook 1998,1999 and 2000 Ho Chi Minh City Service of Culture and Information, January 1999,February 2000 and January 2001.

Table 15.11 Gross Output of Transport, Storage and Tele-communications and Number of Labors Engaged-In

A. Gross Output of Transport, Storage and Telecommunications, and Number of Labors in This Activities

Classified by:	Gross output of transport, storage and tele-communications (million VND)					Annual average growth ratio(%)	Number of labors engaged in transport, storage and tele-communication (persons)					Annual average growth ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
Type of Management:Total	6,631,282	7,592,947	8,794,448	9,685,287	10,853,792	13.11	95,436	100,766	103,763	105,244	105,327	2.50
Central Government	3,667,543	4,637,962	5,789,164	5,694,703	6,482,963	15.31	17,455	21,318	25,541	26,056	26,850	11.37
Ho Chi Minh City	1,495,339	1,617,530	1,788,982	2,087,814	2,298,006	11.34	75,158	77,335	76,115	76,480	75,914	0.25
Foreign investment	1,468,400	1,337,455	1,216,302	1,902,770	2,072,823	9.00	2,823	2,113	2,107	2,708	2,563	-2.39
Economic Sector:Total	6,631,282	7,592,947	8,794,448	9,685,287	10,853,792	13.11	95,436	100,766	103,763	105,244	105,327	2.50
State owned	3,910,179	4,919,369	-	-	-	-	23,403	-	-	-	-	-
Private	1,252,703	1,336,123	-	-	-	-	69,210	-	-	-	-	-
Foreign investment	1,468,400	1,337,455	1,216,302	1,902,770	2,072,823	9.00	2,823	2,113	2,107	2,708	2,563	-2.39
Type of Transport (excluding foreign investment)	5,162,882	6,255,492	7,578,146	9,685,287	10,853,792	20.41	95,436	100,766	103,763	105,244	105,327	2.50
Transport and storage	4,442,938	5,143,150	5,999,627	7,927,055	8,807,391	18.66	89,375	91,959	94,073	95,009	94,940	1.52
Land transport	1,309,457	1,641,250	2,189,953	1,884,696	2,071,129	12.14	73,741	73,490	74,831	71,361	70,658	-1.06
Waterway	922,902	1,175,931	1,483,016	3,584,134	3,999,649	44.28	5,882	7,272	8,557	12,865	13,636	23.39
Railway and airlines	1,392,859	1,406,787	1,395,464	1,479,190	1,701,068	5.12						
Stevedore and storage	817,720	919,182	931,194	979,035	1,035,545	6.08	9,752	11,197	10,685	10,783	10,646	2.22
Postal services and tele-communications	719,944	1,112,342	1,578,519	1,758,232	2,046,401	29.84	6,061	8,807	9,690	10,235	10,387	14.42

B. Share Rate of Total Gross Output (%)

Classified by:						Annual average growth ratio(%)						Annual average growth ratio(%)
	1996	1997	1998	1999	2000		1996	1997	1998	1999	2000	
Type of Management:Total	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Central Government	55.31	61.08	65.83	58.80	59.73	1.94	18.29	21.16	24.61	24.76	25.49	8.65
Ho Chi Minh City	22.55	21.30	20.34	21.56	21.17	-1.56	78.75	76.75	73.35	72.67	72.07	-2.19
Foreign investment	22.14	17.61	13.83	19.65	19.10	-3.63	2.96	2.10	2.03	2.57	2.43	-4.76
Economic Sector:Total	100.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	
State owned	58.97	64.79	-	-	-	-	24.52	-	-	-	-	-
Private	18.89	17.60	-	-	-	-	72.52	-	-	-	-	-
Foreign investment	22.14	17.61	13.83	19.65	19.10	-3.63	2.96	2.10	2.03	2.57	2.43	-4.76
Type of Transport (excluding foreign investment)	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00	
Transport and storage	86.06	82.22	79.17	81.85	81.15	-1.46	93.65	91.26	90.66	90.27	90.14	-0.95
Land transport	25.36	26.24	28.90	19.46	19.08	-6.87	77.27	72.93	72.12	67.81	67.08	-3.47
Waterway	17.88	18.80	19.57	37.01	36.85	19.82	6.16	7.22	8.25	12.22	12.95	20.39
Railway and airlines	26.98	22.49	18.41	15.27	15.67	-12.70	-	-	-	-	-	-
Stevedore and storage	15.84	14.69	12.29	10.11	9.54	-11.90	10.22	11.11	10.30	10.25	10.11	-0.27
Postal services and tele-communications	13.94	17.78	20.83	18.15	18.85	7.83	6.35	8.74	9.34	9.73	9.86	11.63

Source : Statistical Yearbook 1999 and 2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001 .

Table 15.12 Price Index and Exchange Rate in Ho Chi Minh City

A. Consumer Price Index in Ho Chi Minh City (December 1995 = 100)

Items	1996	1997	1998	1999	2000	Annual average growth ratio(%)
General Index	107.10	109.68	119.57	121.44	123.56	3.64%
Eating	109.20	109.67	122.69	122.12	122.00	2.81%
Of which food	101.79	101.62	130.36	111.84	107.40	1.35%
Foodstuff	109.60	108.48	119.30	118.27	116.64	1.57%
Drinking, smoking	101.70	107.07	113.17	115.78	117.78	3.74%
Garment	100.47	103.02	113.42	118.36	119.14	4.35%
Dwelling	108.01	114.69	115.57	114.33	123.98	3.51%
Family goods and equipment	102.58	107.81	110.91	121.44	124.92	5.05%
Public health, health care	101.47	108.32	144.04	144.75	148.79	10.04%
Transport and communication	107.22	112.57	113.22	120.68	130.05	4.94%
Education	106.16	110.76	116.65	122.76	127.64	4.71%
Culture, gymnastic & sport	100.78	106.67	108.89	113.77	114.91	3.33%
Expenditure for consumer goods & other services	104.97	110.50	121.02	125.51	130.00	5.49%
Supplementary index						
Goods	107.03	109.58	119.59	120.07	121.22	3.16%
Services	107.71	111.58	120.64	126.97	132.06	5.23%

B. Exchange Rate (Mid-rate) (VNĐ/US$)

Month	1996	1997	1998	1999	2000
January	11,005	11,280	13,383	13,893	14,128
February	11,007	11,439	13,168	13,863	14,098
March	11,006	11,547	13,214	13,905	14,080
April	11,010	11,676	13,043	13,927	14,098
May	11,011	11,738	12,990	13,927	14,115
June	11,012	11,686	13,010	13,936	14,186
July	11,024	11,684	13,085	13,993	14,170
August	11,031	17,226	13,119	13,975	14,158
September	11,030	11,788	14,180	13,982	14,210
October	11,076	11,818	14,365	14,012	14,358
November	11,140	12,542	13,957	14,015	14,546
December	11,182	12,908	13,919	14,034	14,639
Annual average	11,044	11,819	13,453	13,955	14,232

Source : Statistical Yearbook 1999/2000, Ho Chi Minh City Service of Culture and Information, February 2000 and January 2001.

Table 15.13 Unit Damages to Buildings and Movables Due to Inundation by District

District	Total inun-dated area(ha)	Damages due to inundation (million VNĐ)		Unit damages by District (million VNĐ/ha)	
		1-year flood	10-year flood	1-year flood	10-year flood
District 1	27.11	4,296	4,505	158	166
District 3	65.72	14,309	15,277	218	232
District 4	18.11	3,624	3,911	200	216
District 5	146.65	39,657	45,284	270	309
District 6	336.21	76,434	81,401	227	242
District 8	204.79	47,528	49,558	232	242
District 10	56.49	12,569	14,081	222	249
District 11	98.77	21,717	24,555	220	249
D. Go Vap	337.73	55,819	56,404	165	167
D. Tan Binh	820.73	129,602	129,778	158	158
D. Binh Thanh	656.65	82,346	86,268	125	131
D. Phu Nhuan	47.04	10,218	10,475	217	223
District 12	248.24	0	0	0	0
D. Thu Duc	0.00	0	0	0	0
District 2	140.72	23,148	26,022	164	185
District 9	0.00	0	0	0	0
District 7	180.76	36,153	38,606	200	214
D. Binh Chanh	25.42	6,274	6,521	247	257
D. Nha Be	0.00	0	0	0	0
Total	3,411.14	563,694	592,646	165	174

Table 15.14 Damages to Buildings and Movables by Scale of Flood in Project Area in Present Urbanized Situation

Zone	No.	District	Inundated area (ha)	Unit damages (million VNĐ/ha)		Damages (million VNĐ) due to	
				1-year flood	10-year flood	1-year flood	10-year flood
C-Zone	C-4	District 1	34.31	158	166	5,421	5,695
		District 3	10.27	218	232	2,239	2,383
		District 4	30.08	200	216	6,016	6,497
		District 5	22.78	270	309	6,151	7,040
		District 6	0.00	227	242	0	0
		District 8	201.64	232	242	46,781	48,798
		District 10	13.20	222	249	2,930	3,287
		District 11	0.00	220	249	0	0
		Tan Binh	38.98	158	158	6,159	6,159
		Total	351.26	-	-	75,697	79,858
	C-a	Binh Thanh	12.64	125	131	1,580	1,656
		Total	12.64	-	-	1,580	1,656
	C-b	Binh Thanh	22.15	125	131	2,769	2,902
		Total	22.15	-	-	2,769	2,902
Total of C-Zone			386.06	-	-	80,047	84,416

Table 15.15 Distribution of Inundated Area in Future Urbanized Situation

Zone	No.	District	Total inundated area (ha)	Built-up inundated Area		Agricultural inundated area	
				Present (ha)	Future (ha)	Present (ha)	Future (ha)
C-Zone	C-4	District 1		34.31			
		District 3		10.27			
		District 4		30.08			
		District 5		22.78			
		District 6		0.00			
		District 8		201.64			
		District 10		13.20			
		District 11		0.00			
		Tan Binh		38.98			
		Total	1,273.06	351.26	812.16	921.80	460.90
	C-a	Binh Thanh		12.64			
		Total	12.64	12.64			
	C-b	Binh Thanh		22.15			
		Total	22.15	22.15			
Total of C-Zone			1,307.86	386.06	846.96	921.80	460.90

Table 15.16 Damages to Buildings and Movables by Scale of Flood in Project Area in Future Urbanized Situation

(Note) * : Future urbanized area.

Zone	No.	District	Inundated area (ha)	Unit damages (million VNĐ/ha)		Damages (million VNĐ) due to:	
				1-year flood	10-year flood	1-year flood	10-year flood
C-Zone	C-4	District 1	34.31	158	166	5,421	5,695
		District 3	10.27	218	232	2,239	2,383
		District 4	30.08	200	216	6,016	6,497
		District 5	22.78	270	309	6,151	7,040
		District 6	0.00	227	242	0	0
		District 8	201.64	232	242	46,781	48,798
		District 10	13.20	222	249	2,930	3,287
		District 11	0.00	220	249	0	0
		Tan Binh	38.98	158	158	6,159	6,159
		FUA*	460.90	165	174	76,049	80,197
		Total	812.16	-	-	151,746	160,055
	C-a	Binh Thanh	12.64	125	131	1,580	1,656
		Total	12.64	-	-	1,580	1,656
	C-b	Binh Thanh	22.15	125	131	2,769	2,902
		Total	22.15	-	-	2,769	2,902
Total of C-Zone			846.96	-	-	156,095	164,613

Table 15.17 Average Annual Damages to Buildings and Movables in Project Area

Urbanized situation	Return period	Probability of exceedance	Annual probability	Damages in each return period (mil.VNĐ)	Average amount of assumed damages (mil.VNĐ)	Average annual damages (mil.VNĐ)	Cumulative total of average annual damages (mil.VNĐ)
In Present Urbanized Situation							
	1	1.00000	-	80,047	-	-	-
	10	0.10000	0.90000	84,416	82,232	74,008	74,008
In Future Urbanized Situation							
	1	1.00000	-	156,095	-	-	-
	10	0.10000	0.90000	164,613	160,354	144,319	144,319

Table 15.18 Annual Average Damages to Public Facilities in Project Area

Urbanized situation	Total inundat-ed area (built-up area) (ha)	Area of inundat-ed pubic facilities (ha)	Annual average damages (million VNĐ)
In Present Urbanized Situation			
	746.08	326.56	1,143
In Future Urbanized Situation			
Present	746.08	326.56	1,143
Future	460.90	298.76	1,046
Total	1,206.98	625.31	2,189
(Remarks)			
In Present Urbanized Situation:			
1.	Building density:	56.2%	
2.	Unit damages:	3,500	(VNĐ1,000/ha)
In Future Urbanized Situation:			
1.	Building density:	56.2%	(at present)
		35.2%	(in future)
2.	Unit damages:	3,500	(VNĐ1,000/ha)

Table 15.19 Cultivated Area, Production, Output, Farm Gate Price of Paddy in Ho Chi Minh City

By District	First crops (Winter-Spring Crops)						Second crops (Summer-Autumn Crops)						Third (the Last) crops (Winter Crops)						Total					
	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999	1994	1995	1996	1997	1998	1999
Cultivated Area (ha) : Total																								
District 2										179	180	333				1,563	1,591	1,443	0	0	0	1,742	1,771	1,776
District 6 & 8							125	84	102	88	78	80	468	451	410	357	319	321	593	535	512	445	397	401
District 7										1	0	4				538	442	344	0	0	0	539	442	348
District 9				1,371	1,163	1,342				1,292	1,582	1,618				2,753	2,679	2,739	0	0	0	5,416	5,424	5,699
District 12				398	312	333				417	375	302				672	576	570	0	0	0	1,487	1,263	1,205
Go Vap District	79	81	85	49	25	19	50	43	38	31	17	20	166	114	73	34	19	11	295	238	196	114	61	50
Tan Binh District													63	61	219	211	140	83	63	61	219	211	140	83
Binh Thanh District							77	35	40	41	62	55	239	218	218	218	218	218	316	253	258	259	280	273
Hoc Monh District	2,054	1,938	1,915	1,503	1,514	1,541	1,377	1,428	1,486	1,005	845	1,154	5,296	5,258	4,913	4,181	4,298	4,238	8,727	8,624	8,314	6,689	6,657	6,933
Thu Duc District	1,844	2,046	2,159	431	415	343	2,797	2,815	3,135	524	497	430	6,718	6,533	6,146	719	626	522	11,359	11,394	11,440	1,674	1,538	1,295
Binh Chanh District						14	3,825	3,861	4,339	4,408	4,173	4,460	14,928	14,977	15,186	14,451	13,715	13,534	18,753	18,838	19,525	18,859	17,888	18,008
Nha Be District													6,227	6,182	5,777	5,034	5,348	5,429	6,227	6,182	5,777	5,034	5,348	5,429
Others	6,820	6,802	7,135	8,028	8,165	9,060	5,386	5,674	6,005	5,512	5,802	6,500	21,457	20,938	20,946	20,905	18,427	20,689	33,663	33,414	34,086	34,445	32,394	36,249
Total	10,797	10,867	11,294	11,780	11,594	12,652	13,637	13,940	15,145	13,498	13,611	14,956	55,562	54,732	53,888	51,636	48,398	50,141	79,996	79,539	80,327	76,914	73,603	77,749
Yield (ton)																								
District 2										571	582	1,114				3,808	3,534	4,040	0	0	0	4,379	4,116	5,154
District 6 & 8							560	421	534	385	288	329	1,993	2,030	1,850	1,601	1,347	1,249	2,553	2,451	2,384	1,986	1,635	1,578
District 7										3	0	6				506	349	344	0	0	0	509	349	350
District 9				3,958	3,559	3,885				3,492	4,944	4,756				6,767	5,128	5,470	0	0	0	14,217	13,631	14,111
District 12				1,326	908	956				832	831	689				2,004	1,670	1,880	0	0	0	4,162	3,409	3,525
Go Vap District	254	278	255	167	81	57	155	141	122	100	52	59	532	353	233	108	57	33	941	772	610	375	190	149
Tan Binh District													172	165	385	315	192	125	172	165	385	315	192	125
Binh Thanh District							303	106	124	120	187	165	710	654	486	604	290	545	1,013	760	610	724	477	710
Hoc Monh District	7,019	6,879	7,019	6,316	5,072	5,265	4,406	4,529	4,768	3,233	2,501	3,811	16,127	17,489	11,211	12,952	10,315	11,860	27,552	28,897	22,998	22,501	17,888	20,936
Thu Duc District	5,472	6,452	6,485	1,245	1,419	1,227	9,550	9,563	10,067	1,744	1,746	1,502	15,586	18,039	10,492	2,405	1,878	1,670	30,608	34,054	27,044	5,394	5,043	4,399
Binh Chanh District						25	13,936	15,745	17,446	14,546	14,345	15,709	41,948	46,429	35,766	43,778	35,956	37,800	55,884	62,174	53,212	58,324	50,301	53,534
Nha Be District													16,010	14,219	7,403	12,130	2,014	8,145	16,010	14,219	7,403	12,130	2,014	8,145
Others	22,631	22,694	26,520	28,300	30,211	31,841	17,674	19,178	20,802	18,166	19,827	21,775	62,587	61,932	42,791	63,684	43,369	59,211	102,892	103,804	90,113	110,150	93,407	112,827
Total	35,376	36,303	40,279	41,312	41,250	43,256	46,584	49,683	53,863	43,192	45,303	49,915	155,665	161,310	110,617	150,662	106,099	132,372	237,625	247,296	204,759	235,166	192,652	225,543
Unit Yield (ton/ha)																								
District 2										3.19	3.23	3.35				2.44	2.22	2.80				2.51	2.32	2.90
District 6 & 8							4.48	5.01	5.24	4.38	3.69	4.11	4.26	4.50	4.51	4.48	4.22	3.89	4.31	4.58	4.66	4.46	4.12	3.94
District 7										3.00	0.00	1.50				0.94	0.79	1.00				0.94	0.00	1.01
District 9				2.89	3.06	2.89				2.70	3.13	2.94				2.46	1.91	2.00				2.63	2.51	2.48
District 12				3.33	2.91	2.87				2.00	2.22	2.28				2.98	2.90	3.30				2.80	2.70	2.93
Go Vap District	3.22	3.43	3.00	3.41	3.24	3.00	3.10	3.28	3.21	3.23	3.06	2.95	3.20	3.10	3.19	3.18	3.00	3.00	3.19	3.24	3.11	3.29	3.11	2.98
Tan Binh District													2.73	2.70	1.76	1.49	1.37	1.51	2.73	2.70	1.76	1.49	1.37	1.51
Binh Thanh District							3.94	3.03	3.10	2.93	3.02	3.00	2.97	3.00	2.23	2.77	1.33	2.50	3.21	3.00	2.36	2.80	1.70	2.60
Hoc Monh District	3.42	3.55	3.67	4.20	3.35	3.42	3.20	3.17	3.21	3.22	2.96	3.30	3.05	3.33	2.28	3.10	2.40	2.80	3.16	3.35	2.77	3.36	2.69	3.02
Thu Duc District	2.97	3.15	3.00	2.89	3.42	3.58	3.41	3.40	3.21	3.33	3.51	3.49	2.32	2.76	1.71	3.34	3.00	3.20	2.69	2.99	2.36	3.22	3.28	3.40
Binh Chanh District						1.79	3.64	4.08	4.02	3.30	3.44	3.52	2.81	3.10	2.36	3.03	2.62	2.79	2.98	3.30	2.73	3.09	2.81	2.97
Nha Be District													2.57	2.30	1.28	2.41	0.38	1.50	2.57	2.30	1.28	2.41	0.38	1.50
Others	3.32	3.34	3.72	3.53	3.70	3.51	3.28	3.38	3.46	3.30	3.42	3.35	2.92	2.96	2.04	3.05	2.35	2.86	3.06	3.11	2.64	3.20	2.88	3.11
Overall average	3.28	3.34	3.57	3.51	3.56	3.42	3.42	3.56	3.56	3.20	3.33	3.34	2.80	2.95	2.05	2.92	2.19	2.64	2.97	3.11	2.55	3.06	2.62	2.90
Output (VNĐ million) in Ho Chi Minh City																			340,009	372,409	320,386	381,629	370,939	433,922
Farm Gate Price of Paddy (VNĐ1,000/ton)																			1,431	1,506	1,565	1,623	1,925	1,924

Source : Statistical Yearbook 1997 and 1999, Ho Chi Minh City Service of Culture and Information.

Table 15.20 Percentage of Decrease in Yield of Paddy Due to Inundation by Growing Stage

(%)

Flooding condition		Tillering stage	Booting stage	Heading time	Ripening stage
Overhead flooding	1 - 2 days	10	70	30	5
	3 - 4 days	20	80	80	20
	5 - 6 days	30	85	90	30
	Over 7 days	35	95	100	30
Inundation up to 75 % of plant height	1 - 2 days	6	40	10	4
	3 - 4 days	9	46	23	15
	5 - 6 days	14	49	26	23
	Over 7 days	16	55	30	23
Inundation up to 50 % of plant height	1 - 2 days	4	37	8	2
	3 - 4 days	9	42	22	4
	5 - 6 days	13	45	25	6
	Over 7 days	15	50	28	6

Source : Results of experiments made by Dr. S. Matsushima in Malaysia in 1968.

Table 15.21 Damages to Paddy by Scale of Flood in Each Zone in Present Urbanized Situation

Zone	No.	Inundated area (Agri. land) (ha)	Inundation depth 1-year flood (cm)	Inundation depth 10-year flood (cm)	Duration 1-year flood (day)	Duration 10-year flood (day)	% of decrease in paddy 1-year flood	% of decrease in paddy 10-year flood	Damages (million VNĐ) due to: 1-year flood	Damages (million VNĐ) due to: 10-year flood
C-Zone	C.4	921.80	28.0	52.0	Less than 1	1	0%	37%	0	1,138
N-Zone	N.1	162.05 *	50.0	80.0	More than 7	More than 7	55%	95%	297	514
	N.2	1,472.38 *	26.0	26.0	Less than 1	Less than 1	0%	0%	0	0
	N.a	539.49 *	50.0	80.0	More than 7	More than 7	55%	95%	990	1,710
	Total	2,173.92							1,288	2,224
W-Zone	W.1	3,190.30	22.0	23.0	Less than 1	Less than 1	0%	0%	0	0
S-Zone	S.1	1,128.50	50.0	80.0	3 - 4	3 - 4	46%	80%	1,732	3,013
	S.2	1,053.40	50.0	80.0	3 - 4	3 - 4	46%	80%	1,617	2,812
	S.3	2,730.00	21.0	30.0	Less than 1	Less than 1	0%	0%	0	0
	S.5	91.20	20.0	25.0	Less than 1	Less than 1	0%	0%	0	0
	S.b	340.00	20.0	25.0	Less than 1	Less than 1	0%	0%	0	0
	S.c	525.30	50.0	80.0	3 - 4	3 - 4	46%	80%	806	1,402
	Total	5,868.40							4,155	7,227
NE-Zone	NE.1	326.20	50.0	80.0	More than 7	More than 7	55%	95%	599	1,034
	NE.2	637.50	50.0	80.0	More than 7	More than 7	55%	95%	1,170	2,021
	NE.5	279.80	50.0	80.0	More than 7	More than 7	55%	95%	514	887
	NE.a	368.00	50.0	80.0	More than 7	More than 7	55%	95%	675	1,167
	NE.b	25.70	50.0	80.0	More than 7	More than 7	55%	95%	47	81
	Total	1,637.20							3,005	5,190
SE-Zone	SE.1	155.70	50.0	80.0	More than 7	More than 7	55%	95%	286	494
	SE.2	85.60	20.0	35.0	1	1	37%	37%	106	106
	SE.4	515.40	20.0	20.0	Less than 1	Less than 1	0%	0%	0	0
	SE.5	281.00	50.0	80.0	More than 7	More than 7	55%	95%	516	891
	SE.6	324.70	50.0	80.0	More than 7	More than 7	55%	95%	596	1,029
	SE.7	818.40	50.0	80.0	More than 7	More than 7	55%	95%	1,502	2,594
	SE.8	889.60	50.0	80.0	More than 7	More than 7	55%	95%	1,633	2,820
	SE.9	1,582.20	50.0	80.0	More than 7	More than 7	55%	95%	2,904	5,016
	SE.10	2,201.80	50.0	80.0	More than 7	More than 7	55%	95%	4,041	6,980
	SE.b	241.70	20.0	30.0	Less than 1	Less than 1	0%	0%	0	0
	SE.c	123.60	50.0	80.0	More than 7	More than 7	55%	95%	227	392
	SE.d	20.10	50.0	80.0	More than 7	More than 7	55%	95%	37	64
	SE.e	262.40	50.0	80.0	More than 7	More than 7	55%	95%	482	832
	SE.f	841.60	50.0	80.0	More than 7	More than 7	55%	95%	1,545	2,668
	Total	8,343.80							13,872	23,884
Grand total									22,320	39,663

Remarks : Farm gate price of paddy as of 1999 - 1,924 (VND1,000/ton)
Unit yield of paddy - 2.87 (ton/ha, average yield since 1994)
Damaged rate of total paddy production - 60.43% (The third crops = winter crops are damaged during the flooding season. Average percentage since 1994)

(Note) * Assumed that 30 % of agricultural area is already urbanized, so deduced.

Table 15.22 Damages to Paddy by Scale of Flood in Each Zone in Future Urbanized Situation

Zone	No.	Inundated area (Agri. land) (ha)	Inundation depth		Duration		% of decrease in paddy		Damages (million VNĐ) due to:	
			1-year flood (cm)	10-year flood (cm)	1-year flood (day)	10-year flood (day)	1-year flood	10-year flood	1-year flood	10-year flood
C-Zone	C.4	460.90	28.0	52.0	Less than 1	1	0%	37%	0	569
N-Zone	N.1	115.75	50.0	80.0	More than 7	More than 7	55%	95%	212	367
	N.2	1,051.70	26.0	26.0	Less than 1	Less than 1	0%	0%	0	0
	N.a	385.35	50.0	80.0	More than 7	More than 7	55%	95%	707	1,222
	Total	1,552.80							920	1,589
W-Zone	W.1	1,595.15	22.0	23.0	Less than 1	Less than 1	0%	0%	0	0
S-Zone	S.1	564.25	50.0	80.0	3 - 4	3 - 4	46%	80%	866	1,506
	S.2	526.70	50.0	80.0	3 - 4	3 - 4	46%	80%	808	1,406
	S.3	1,365.00	21.0	30.0	Less than 1	Less than 1	0%	0%	0	0
	S.5	45.60	20.0	25.0	Less than 1	Less than 1	0%	0%	0	0
	S.b	170.00	20.0	25.0	Less than 1	Less than 1	0%	0%	0	0
	S.c	262.65	50.0	80.0	3 - 4	3 - 4	46%	80%	403	701
	Total	2,934.20							2,078	3,613
NE-Zone	NE.1	163.10	50.0	80.0	More than 7	More than 7	55%	95%	299	517
	NE.2	318.75	50.0	80.0	More than 7	More than 7	55%	95%	585	1,010
	NE.5	139.90	50.0	80.0	More than 7	More than 7	55%	95%	257	443
	NE.a	184.00	50.0	80.0	More than 7	More than 7	55%	95%	338	583
	NE.b	12.85	50.0	80.0	More than 7	More than 7	55%	95%	24	41
	Total	818.60							1,502	2,595
SE-Zone	SE.1	77.85	50.0	80.0	More than 7	More than 7	55%	95%	143	247
	SE.2	42.80	20.0	35.0	1	1	37%	37%	53	53
	SE.4	257.70	20.0	20.0	Less than 1	Less than 1	0%	0%	0	0
	SE.5	140.50	50.0	80.0	More than 7	More than 7	55%	95%	258	445
	SE.6	162.35	50.0	80.0	More than 7	More than 7	55%	95%	298	515
	SE.7	409.20	50.0	80.0	More than 7	More than 7	55%	95%	751	1,297
	SE.8	444.80	50.0	80.0	More than 7	More than 7	55%	95%	816	1,410
	SE.9	791.10	50.0	80.0	More than 7	More than 7	55%	95%	1,452	2,508
	SE.10	1,100.90	50.0	80.0	More than 7	More than 7	55%	95%	2,020	3,490
	SE.b	120.85	20.0	30.0	Less than 1	Less than 1	0%	0%	0	0
	SE.c	61.80	50.0	80.0	More than 7	More than 7	55%	95%	113	196
	SE.d	10.05	50.0	80.0	More than 7	More than 7	55%	95%	18	32
	SE.e	131.20	50.0	80.0	More than 7	More than 7	55%	95%	241	416
	SE.f	420.80	50.0	80.0	More than 7	More than 7	55%	95%	772	1,334
	Total	4,171.90							6,936	11,942
Grand total									11,436	20,308

Remarks : Farm gate price of paddy as of 1998 - 1,924 (VND1,000/ton)
Unit yield of paddy - 2.87 (ton/ha, average yield since 1994)
Damaged rate of total paddy production - 60.43% (The third crops = winter crops are damaged during the flooding season. Average percentage since 1994)

Table 15.23 Average Annual Damages to Paddy in Project Area

A. In Present Urbanized Situation

Zone	Return period	Probability of exceedance	Annual probability	Damages in each return period (mil.VNĐ)	Average amount of assumed damages (mil.VNĐ)	Average annual damages (mil.VNĐ)	Cumulative total of average annual damages (mil.VNĐ)
C-Zone	1	1.00000	-	0	-	-	-
	10	0.10000	0.90000	1,138	569	512	512

B. In Future Urbanized Situation

Zone	Return period	Probability of exceedance	Annual probability	Damages in each return period (mil.VNĐ)	Average amount of assumed damages (mil.VNĐ)	Average annual damages (mil.VNĐ)	Cumulative total of average annual damages (mil.VNĐ)
C-Zone	1	1.00000	-	0	-	-	-
	10	0.10000	0.90000	569	285	256	256

Table 15.24 Summary of Average Annual Direct Damages in Project Area

Kind of direct damages	In Vietnamese Dong (million VN~~Đ~~)	
	At present	In future(by Project)
Buildings and movables	74,008	144,319
Public facilities	1,143	2,189
Agricultural crops (paddy)	512	256
Total	75,663	146,764

Table 15.25 Income by Source and Share Rate of Trading and Services in the Study Area

District	Item		Income by income sources									Share rate(%) of trading/ services
			Small industries	Handi-craft	Trading	Service (hairdress, car/bike garage)	Govern-ment officials	Police, armies	Agricul-ture	Others	Total	
District 1	No. of samples		0	7	13	9	18	0	0	0	47	46.81%
	Income in total	(1,000VND)	0	19,700	42,400	28,800	58,100	0	0			
	Average monthly income	(1,000VND/HH)	0	2,814	3,262	3,200	3,228	0	0			
District 3	No. of samples		2	2	25	11	19	3	1	4	67	66.00%
	Double count		(-2)	(-2)	(-1)	(-2)	(-9)	(-3)	(-1)			
	Income in total	(1,000VND)	0	0	36,900	16,900	19,830	0	0	6,000		
	Average monthly income	(1,000VND/HH)	0	0	1,538	1,878	1,983	0	0	1,500		
District 4	No. of samples		1	1	29	14	7	0	0		52	82.35%
	Double count			(-1)		(-1)						
	Income in total	(1,000VND)	400	0	67,500	34,000	10,000	0	0	0		
	Average monthly income	(1,000VND/HH)	400	0	2,328	2,615	1,429	0	0	0		
District 5	No. of samples		1	0	29	6	16	1	0	0	53	66.67%
	Double count					(-1)	(-1)	(-1)				
	Income in total	(1,000VND)	500	0	39,650	3,500	19,100	0	0	0		
	Average monthly income	(1,000VND/HH)	500	0	1,367	700	1,273	0	0	0		
District 6	No. of samples		1	6	25	2	20	1	0	0	55	48.15%
	Double count					(-1)		(-1)				
	Income in total	(1,000VND)	5,000	5,050	40,400	800	94,100	0	0	0		
	Average monthly income	(1,000VND/HH)	5,000	842	1,616	800	4,705	0	0	0		
District 8	No. of samples		1	3	31	4	31	1	0		71	59.32%
	Double count						(-12)					
	Income in total	(1,000VND)	6,000	7,000	72,000	12,500	47,900	500	0	0		
	Average monthly income	(1,000VND/HH)	6,000	2,333	2,323	3,125	2,521	500	0	0		
District 10	No. of samples		0	3	18	10	31	2	0	2	66	44.26%
	Double count					(-1)	(-5)					
	Income in total	(1,000VND)	0	4,600	29,200	14,450	47,200	2,000	0	5,000		
	Average monthly income	(1,000VND/HH)	0	1,533	1,622	1,606	1,815	1,000	0	2,500		
District 11	No. of samples		4	7	26	5	15	4	1	0	62	58.82%
	Double count		(-3)	(-1)		(-1)	(-5)	(-1)	(-1)			
	Income in total	(1,000VND)	1,500	14,500	83,100	13,000	29,100	3,500	0	0		
	Average monthly income	(1,000VND/HH)	1,500	2,417	3,196	3,250	2,910	1,167	0	0		
Go Vap	No. of samples		2	8	18	5	23	3	0	1	60	41.51%
	Double count			(-3)		(-1)	(-2)	(-2)				
	Income in total	(1,000VND)	2,500	5,300	32,900	4,500	35,220	2,000	0	600		
	Average monthly income	(1,000VND/HH)	1,250	1,060	1,828	1,125	1,677	2,000	0	600		
Tan Binh	No. of samples		2	10	26	6	24	5	0	1	74	46.77%
	Double count			(-3)		(-3)	(-6)	(-3)				
	Income in total	(1,000VND)	3,300	10,700	64,400	2,700	36,600	3,000	0	500		
	Average monthly income	(1,000VND/HH)	1,650	1,529	2,477	900	2,033	1,500	0	500		
Binh Thanh	No. of samples		0	0	35	13	15	2	1	1	67	68.75%
	Double count					(-4)	(-3)					
	Income in total	(1,000VND)	0	0	53,400	14,600	18,900	3,900	2,000	900		
	Average monthly income	(1,000VND)	0	0	1,526	1,622	1,575	1,950	2,000	900		
Phu Nhuan	No. of samples		2	4	17	6	35	1	0	0	65	42.31%
	Double count		(-1)	(-2)		(-1)	(-9)	(-1)				
	Income in total	(1,000VND)	1,000	1,300	26,100	7,200	41,200	0	0	0		
	Average monthly income	(1,000VND/HH)	1,000	650	1,535	1,440	1,585	0	0	0		
District 12	No. of samples		7	4	19	3	11	0	33	0	77	40.38%
	Double count			(-2)		(-1)	(-6)		(-19)			
	Income in total	(1,000VND)	7,500	4,900	25,050	3,000	6,600	0	9,310	0		
	Average monthly income	(1,000VND/HH)	1,071	2,450	1,318	1,500	1,320	0	665	0		
Thu Duc	No. of samples		0	4	11	9	24	2	10	0	60	38.00%
	Double count					(-1)	(-6)	(-1)	(-3)			
	Income in total	(1,000VND)	0	11,500	36,500	20,500	56,000	1,000	16,500	0		
	Average monthly income	(1,000VND/HH)	0	2,875	3,318	2,563	3,111	1,000	2,357	0		
District 2	No. of samples		4	4	12	3	25	0	2	7	57	26.42%
	Double count			(-1)		(-1)	(-4)					
	Income in total	(1,000VND)	1,500	5,500	25,530	4,500	45,200	0	4,000	4,220		
	Average monthly income	(1,000VND/HH)	375	1,833	2,128	2,250	2,152	0	2,000	603		
District 9	No. of samples		0	0	14	3	6	0	32	0	55	33.33%
	Double count								(-4)			
	Income in total	(1,000VND)	0	0	9,100	2,800	4,300	0	13,100			
	Average monthly income	(1,000VND/HH)	0	0	650	933	717	0	468	0		
District 7	No. of samples		1	3	7	16	20	4	5	1	57	46.00%
	Double count						(-5)	(-2)				
	Income in total	(1,000VND)	2,000	1,800	12,900	45,700	20,500	2,500	8,200	1,000		
	Average monthly income	(1,000VND/HH)	2,000	600	1,843	2,856	1,367	1,250	1,640	1,000		
Binh Chanh	No. of samples		1	5	25	13	19	2	2	0	67	55.56%
	Double count					(-3)	(-3)	(-1)				
	Income in total	(1,000VND)	2,000	8,500	59,300	21,000	37,500	1,500	3,000	0		
	Average monthly income	(1,000VND/HH)	2,000	1,700	2,372	2,100	2,344	1,500	1,500	0		
Nha Be	No. of samples		0	0	7	4	16	1	34	0	62	23.26%
	Double count					(-1)	(-3)		(-16)			
	Income in total	(1,000VND)	0	0	9,200	2,000	10,000	500	11,500	0		
	Average monthly income	(1,000VND/HH)	0	0	1,314	667	769	500	639	0		
Average												49.19%

Source : Flood Damages Survey made by JICA Study Team, 1998.

Table 15.26 Number of Households Engaging in Trading and Services in Project Area

No.	District	Inundated area (ha)	Flood vulnerable population 1997	Flood vulnerable population 2010	Flood vulnerable population 2020	Total number of households (HH) 1997	Total number of households (HH) 2010	Total number of households (HH) 2020	Share rate (%)	Number of HHs engaging in trading & services 1997	Number of HHs engaging in trading & services 2010	Number of HHs engaging in trading & services 2020
C-4	District 1	34.31	24,423	23,556	22,915	4,277	4,125	4,013	47%	2,002	1,931	1,879
	District 3	10.27	9,610	9,286	9,045	1,683	1,626	1,584	66%	1,111	1,073	1,045
	District 4	30.08	19,659	19,432	19,265	3,443	3,403	3,374	82%	2,835	2,802	2,778
	District 5	22.78	15,214	14,096	13,301	2,664	2,469	2,329	67%	1,776	1,646	1,553
	District 6	0.00	0	0	0	0	0	0	48%	0	0	0
	District 8	201.64	77,393	68,441	62,973	13,554	11,986	11,029	59%	8,040	7,110	6,542
	District 10	13.20	6,750	6,731	6,717	1,182	1,179	1,176	44%	523	522	521
	District 11	0.00	0	0	0	0	0	0	59%	0	0	0
	Tan Binh	38.98	19,098	19,787	20,335	3,345	3,465	3,561	47%	1,564	1,621	1,666
	Total	351.26	172,147	161,330	154,550	30,148	28,254	27,067		17,852	16,706	15,984
C-a	Binh Thanh	12.64	3,535	3,813	4,048	619	668	709	69%	426	459	487
	Total	12.64	3,535	3,813	4,048	619	668	709		426	459	487
C-b	Binh Thanh	22.15	2,880	3,382	3,828	504	592	670	69%	347	407	461
	Total	22.15	2,880	3,382	3,828	504	592	670		347	407	461
Total of C-Zone		386.06	178,563	168,526	162,426	31,272	29,514	28,446		18,625	17,572	16,932

(Note) Average family size : 5.71 (persons/HH)

Table 15.27 Business Suspension Losses in Project Area

Zone	No.	Number of households engaging in trading and services			Increasing ratio (% per annum)		Average flood duration	Business suspension days	Annual average damages due to business suspension (million VNĐ)			
					From 1997	From 2010						
		1997	2010	2020	to 2010	to 2020	(hours)	(days)	1997	1999	2010	2020
C-Zone	C.4	17,852	16,706	15,984	-0.51%	-0.44%	6.1	1.0	16,281	16,198	15,236	14,577
	C.a	426	459	487	0.58%	0.59%	4.0	1.0	389	391	419	444
	C.b	347	407	461	1.23%	1.25%	3.1	1.0	316	320	371	420
	Total	18,625	17,572	16,932	-0.45%	-0.37%			16,986	16,909	16,026	15,442

Remarks : Unit losses = 911,995 (VND/HH.day as of 1998). Based on the statistical data shown in Table 15.1.10.

Table 15.28 Income Losses in Project Area

Zone	Catch-ment area	Flood Vulnerable Population								Suspension days		Annual average income losses			
		Built-up Area		Increasing	Agricultural Land		Increasing	Total				Built-up area(mil.VNĐ)		Agricultural area(mil.VNĐ)	
	No.	1997	2020	ratio (%)	1997	2020	ratio (%)	1997	2020	Trading/ services	Agri-culture	1999	2020	1999	2020
C-Zone	C.4	15,214	13,301	-0.58%	19,723	67,070	5.47%	34,937	80,371	1.0	1.0	235	207	219	706
	C.a	3,535	4,048	0.59%	0	0		3,535	4,048	1.0		55	63		
	C.b	2,880	3,826	1.24%	0	0		2,880	3,826	1.0		45	59		
	Total	21,629	21,175	-0.09%	19,723	67,070	5.47%	41,352	88,245			336	329	219	706

Remarks : 1. Daily income per person for workers: 41,880 (VND/day.person as of 1999. Based on the data shown in Table 15.1.10).

2. Daily income per person for farmers: 28,348 (VND/day.person as of 1999, see below).

Calculation :

Item	Gross output (tri.VNĐ)	Nos. of farmers (persons)	Daily income (VNĐ/day)
1994	1,281	248,164	17,213
1995	1,620	238,893	22,607
1996	1,738	237,096	24,432
1997	1,863	238,214	26,069
1998	1,933	239,821	26,871
1999	2,050	241,058	28,348

Source: Statistical Yearbook of Ho Chi Minh City, 1998 and 1999.

3. Average family size : 5.71 (as results of Interview Survey on "Social Survey of Relocation/Resettlement" made by JICA
4. Number of working persons per HH : 2.12 Study Team, 1998).

Source : See Table E.5.3 for "Flood Vulnerable Population" in "The Study on Urban Drasinage and Sewerage System for Ho Chi Minh City in the Socialist Republic of Viet Nam" Final Report by JICA, December 1999.

Table 15.29 Basic Data and Information on Medical Affairs

A. Basic Data on Patients

Item	1994	1995	1996	1997	Average
Inpatients	490,817	522,025	554,447	586,992	538,570
Outpatients	361,873	471,660	620,817	741,123	548,868
Staying days in hospitals (days)	8.09	7.92	7.83	7.96	7.95
Visiting days to hospitals (days)	13.70	13.50	13.50	12.41	13.28
Total number of patients	11,318,412	12,479,597	13,707,635	14,597,596	13,025,810
Average number of patients per day	33,289	36,705	40,317	42,934	38,311

B. Medical Cost (As of 1998)

Kind of cost	Amount (mil.VNĐ)
Medical subsidies from Ho Chi Minh City to hospitals :	293,150
Medical cost collected from patients :	21,000
Medical cost paid from medical insurance :	50,000
Total	364,150

C. Rate of Water Borne Diseases (As of 1997)

Name of disease	Water borne disease	Faecal disposal related disease	Housing and crowding related disease	Others	Total
Hepatitis		1,032			1,032
Mumps			1,053		1,053
Measles			1,302		1,302
Whooping cough			319		319
Chicken pox			225		225
Diarrhea	40,827				40,827
Trachoma	264				264
Pneumonia and influenza			17,862		17,862
Mal of poisoning			1,718		1,718
Shigellosis		468			468
Meningitis viral			57		57
Typhoid	674				674
Certain infectious and parasitic disease				82,175	82,175
Total	41,765	1,500	22,536	82,175	147,976
Share rate (%)	28.22%	1.01%	15.23%	55.53%	100.00%

Source : Department of Health, Ho Chi Minh City.

Table 15.30 Saving Amount of Medical Fees in Project Area

Built-up/agricultural	Catch-ment area	Flood Vulnerable Population				Number of total patients suffered by water borne disease		Amount of medical fees for total patients suffered by water borne d.		Number of outpatients suffered by water borne disease		Amount of income to be received during visiting days to hospitals		Number of inpatients suffered by water borne disease		Amount of income to be received during staying days in hospitals	
		1997	1999	2020	Increas-ing ratio	(persons)		(milion VNĐ)		(persons)		(milion VNĐ)		(persons)		(milion VNĐ)	
	No.				(%)	1999	2020	1999	2020	1999	2020	1999	2020	1999	2020	1999	2020
In Built-up Area																	
	C.4	15,214	15,037	13,301	-0.58%	277	245	93	82	140	124	78	69	137	122	46	40
	C.a	3,535	3,577	4,048	0.59%	66	75	22	25	33	38	19	21	33	37	11	12
	C.b	2,880	2,952	3,826	1.24%	54	71	18	24	27	36	15	20	27	35	9	12
	Total	21,629	21,566	21,175	-0.09%	398	391	133	131	201	197	112	110	197	193	66	64
In Agricultural Area																	
	C.4	19,723	20,801	67,070	5.47%	384	1,237	129	414	194	625	73	235	190	613	43	138
	C.a	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
	C.b	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
	Total	19,723	20,801	67,070	5.47%	384	1,237	129	414	194	625	73	235	190	613	43	138

Note:			
	Total population in HCMC :	4,989,703	(As of 1997, Statistical Yearbook of Ho Chi Minh City, 1998)
	Annual average outpatients :	548,868	(See Table 15.2.17)
	Annual average inpatients :	538,570	(See Table 15.2.17)
	Total patients :	1,087,438	
	Share rate of water borne diseases :	28.22%	(See Table 15.2.17)
	Total medical cost :	364,150	(million VNĐ, see Table 15.2.17)
	Medical cost per patient :	334,870	(VNĐ/patient)
	Average daily income for workers :	41,880	(VNĐ/patient, see Table 15.2.16)
	Average daily income for farmers :	28,348	(VNĐ/patient, see Table 15.2.16)
	Average days staying in hospital :	7.95	(days/inpatient, see Table 15.2.17)
	Average days to visit to hospital :	13.28	(days/outpatient, see Table 15.2.17)
	Estimation of impact of the Project :	30%	(Assumed)

Table 15.31 Estimation of Navigation Benefit in Project Area

Items/estimation factors	Amount/figures		
Gross output of inland waterway transportation[1)]	(million VNĐ)	1994	562,150
		1995	702,181
		1996	922,902
		1997	1,175,931
		1998	1,483,016
		1999	1,492,579
Estimation of per hour inland waterway transportation charge at present situation			
Working days per year (days/annum)[2)]	(days/annum)		365
Working hours per day (hours/day)[2)]	(hours/day)		12
Per hour waterway transportation charge	(million VNĐ/hour)		341
Estimation of navigation benefit at present situation			
Registered ships/boats in whole Ho Chi Minh City	ships		3,000
Registered ships/boats along the Tau Hu - Be Nghe C	ships		300
Share rate of Tau Hu - Be Nhge Canal[3)]	(%)		10.00%
Existing harboring rate[4)]	(%)		75.00%
Improved harboring rate by excavation[4)]	(%)		90.00%
Benefited harboring rate	(%)		15.00%
Benefited waiting time per day[4)]	(hours/day)		7.00
Amount of benefit at present (as of 1998)	(million VNĐ/annum)		13,060
Estimation of navigation benefit at future situation			
Population in whole HCMC at present (as of 1997)	(persons)		4,415,147
Population in whole HCMC in future (as of 2020)	(persons)		7,608,615
Increasing ratio of population	(%)		2.39%
Amount of benefit in future (as of 2020)	(million VNĐ/annum)		21,980

(Note)

1) Based on the Statistical Yearbook 1997, 1998, and 1999.
2) Assumed.
3) Based on an information of UNDP.
4) Based on an information of "Pre-Feasibility Study on Improvement, Construction & Rehabilitation of Tau Hu - Doi - Te Canals" studied by HCMC Transportation and Public Works together with the Construction Consulting Company, 1998.

Table 15.32 Summary of Indirect Benefit in Project Area

Item	In million VNĐ					
	Built-up area		Agricultural area		Total	
	1999	2020	1999	2020	1999	2020
Business suspension losses					16,909	15,442
Income loss due to inundation	336	329	219	706	555	1,035
Saving amount of medical fees and incom	311	305	245	787	556	1,092
Saving amount of medical fees	133	131	129	414	262	545
Income losses for outpatients	112	110	73	235	185	345
Income losses for inpatients	66	64	43	138	109	202
Navigation benefit					13,060	21,980
Total	647	634	464	1,493	31,080	39,549

Table 15.33 Estimation of Standard Conversion Factor

(Note)

Equation for calculation of standard conversion factor (SCF):

$$\mathbf{SCF} = \frac{\textbf{Import amount + Export amount}}{\textbf{(Import amount + Import customs) + (Export amount - Export tax + Excise duties)}}$$

(1,000 US$)

Year	Import amount	Export amount	Import customs	Export taxes	Excise duties
1994	1,976,785	1,694,375	413,954	0	0
1995	2,378,096	2,367,665	599,296	0	0
1996	3,179,976	3,473,175	681,109	0	0
1997	3,066,488	3,295,808	673,154	0	0
1998	2,632,893	3,037,241	591,393		
1999	2,382,685	3,796,256	535,192 *		
Total	15,616,923	17,664,520	3,494,098	0	0
(Note) Refer to Table 15.1.3.				SCF=	0.90499

* Presumed from the record of 1998.

Table 15.34 Annual Disbursement of Construction Cost and Estimation of Its Economic Cost

(billion VNĐ)

Cost item	Distribution																				
	2000			2001			2002			2003			2004			2005			Total in 1st Phase		
	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Total
Construction works				20.1	47.0	67.1	33.5	78.3	111.8	33.5	78.3	111.8	33.5	78.3	111.8	13.4	31.3	44.7	134.1	313.0	447.1
Dredging equipment																		0.0	0.0	0.0	0.0
Engineering cost	11.0	4.7	15.7	2.2	0.9	3.1	2.2	0.9	3.1	2.2	0.9	3.1	2.2	0.9	3.1	2.2	0.9	3.1	21.9	9.4	31.3
Compensation cost	0.0	87.0	87.0	0.0	32.6	32.6	0.0	32.6	32.6	0.0	32.6	32.6	0.0	32.6	32.6	0.0	0.0	0.0	0.0	217.6	217.6
Sub total	11.0	91.7	102.7	22.3	80.5	102.8	35.7	111.8	147.6	35.7	111.8	147.6	35.7	111.8	147.6	15.6	32.2	47.8	156.1	540.0	696.0
Administration	0.0	4.0	4.0	0.0	3.2	3.2	0.0	3.2	3.2	0.0	3.2	3.2	0.0	3.2	3.2	0.0	3.2	3.2	0.0	19.9	19.9
Sub-total	11.0	95.7	106.7	22.3	83.7	106.0	35.7	115.0	150.7	35.7	115.0	150.7	35.7	115.0	150.7	15.6	35.4	51.0	145.1	464.2	609.3
Physical conti.	0.0	0.0	0.0	2.0	4.7	6.7	3.4	7.8	11.2	3.4	7.8	11.2	3.4	7.8	11.2	1.3	3.1	4.5	13.4	31.3	44.7
Financial cost	11.0	95.7	106.7	24.3	88.4	112.7	39.1	122.8	161.9	39.1	122.8	161.9	39.1	122.8	161.9	16.9	38.6	55.5	169.5	591.2	760.7
Economic cost	9.9	95.2	105.1	21.9	77.5	99.4	35.2	104.8	140.0	35.2	104.8	140.0	35.2	104.8	140.0	15.3	31.3	46.5	152.5	518.5	671.0

(billion VNĐ)

Cost item	Distribution																						
	2005			2006			2007			2008			2009			2010			Total in 2nd Phase			Total in Whole Works		
	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Sub-total	FC	LC	Total	FC	LC	Total
Construction works				52.3	122.1	174.4	52.3	122.1	174.4	26.2	61.0	87.2							130.8	305.1	435.9	264.9	618.1	883.1
Dredging equipment												0.0							0.0	0.0	0.0	0.0	0.0	0.0
Engineering cost	10.7	4.6	15.3	4.3	1.8	6.1	3.2	1.4	4.6	3.2	1.4	4.6							21.4	9.2	30.5	43.3	18.5	61.8
Compensation cost	0.0	1.5	1.5	0.0	0.6	0.6	0.0	0.4	0.4	0.0	0.4	0.4							0.0	2.9	2.9	0.0	220.5	220.5
Sub total	10.7	6.0	16.7	56.6	124.5	181.0	55.5	123.9	179.4	29.4	62.8	92.2							152.1	317.2	469.3	308.2	857.1	1,165.3
Administration	0.0	3.3	3.3	0.0	3.3	3.3	0.0	3.3	3.3	0.0	3.3	3.3							0.0	13.2	13.2	0.0	33.1	33.1
Sub-total	10.7	9.3	20.0	56.6	127.8	184.3	55.5	127.2	182.7	29.4	66.1	95.5							141.5	321.0	462.5	286.6	785.2	1,071.8
Physical conti.	0.0	0.0	0.0	5.2	12.2	17.4	5.2	12.2	17.4	2.6	6.1	8.7							13.1	30.5	43.6	26.5	61.8	88.3
Financial cost	10.7	9.3	20.0	61.8	140.0	201.8	60.7	139.4	200.1	32.0	72.2	104.2							165.2	360.9	526.1	334.7	952.1	1,286.7
Economic cost	9.6	8.9	18.5	55.6	111.8	167.4	54.7	111.2	165.9	28.8	58.1	86.9							148.7	290.0	438.7	301.2	808.4	1,109.7

Remarks:

1. Price share rates of construction:
   - Labour 0% 30%
   - Equipment and Material 100% 70%
2. Tax : 10 % for construction and engineering services.
3. Contractor's overhead & profit: 10%
4. Standard conversion factor: 0.9050 (Refer to Table 15.2.2)
5. Shadow wage rate (economic wage rate): 70%
6. Price : As of June 2000.
7. Conversion rate : US$ 1.00 = VND14,086 and US$1.00= \105.58 as of the end of May 2000.

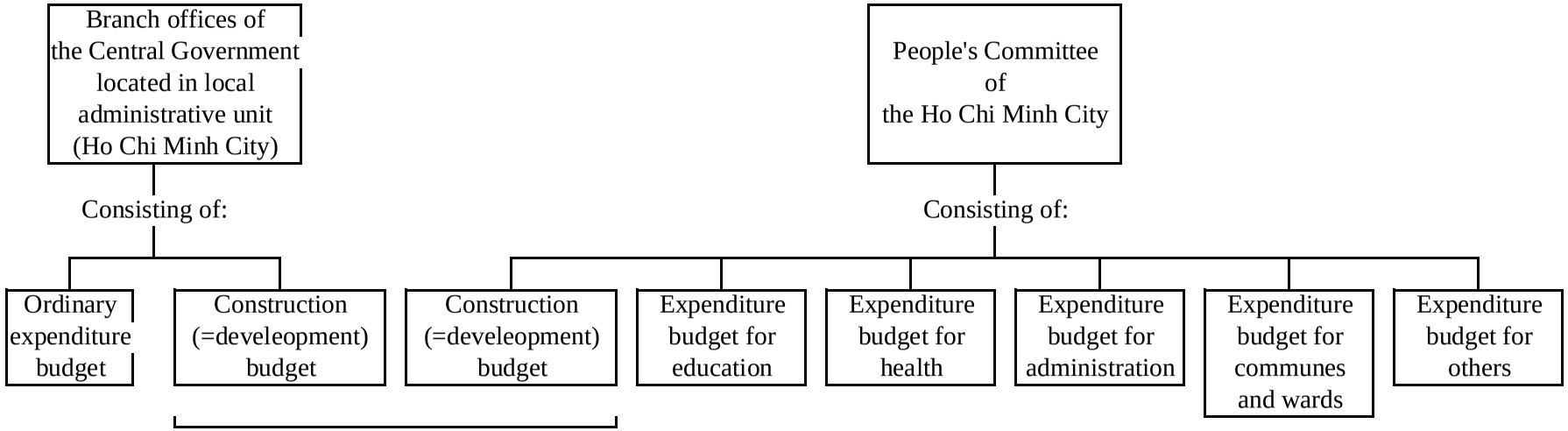
8. Operation/maintenance and replacement cost:

Annualized work item	Phase 1	Phase 2	Total
Labour cost	2.4	0.2	2.6
Material/Equipment	4.7	0.1	4.8
Financial cost	7.1	0.3	7.4
Economic cost	5.9	0.2	6.1

9. Replacement cost
   Phase-1(F. cost:5.0/year): 4.3 (billion VNĐ/year)
   Phase-2(F. cost:4.3/year): 3.7 (billion VNĐ/year)

Table 15.35 Calculation of Economic Internal Rate of Return for the Urban Drainage Systm Improvement Work

Year in order	Year	Cost											Benefit						Cash balance
		1st phase					2nd phase					Cost in total	Direct benefit	Indirect benefit				Total	
		Construction		OM cost	Reserve for replacement	Sub-total	Construction		OM cost	Reserve for replacement	Sub-total			Business	Income	Medic'l	Navi'tion		
		F/C	L/P				F/C	L/C											
(Base year)													75.7	17.6	0.7	0.7	13.1		
1	2000	9.9	95.2	0.0		105.1					0.0	105.1						0.0	-105.1
2	2001	21.9	77.5	0.0		99.4					0.0	99.4						0.0	-99.4
3	2002	35.2	104.8	0.0		140.0					0.0	140.0	77.0	17.6	0.7	0.7	13.2	109.2	-30.8
	2003	35.2	104.8	0.0		140.0					0.0	140.0	75.7	17.6	0.7	0.7	13.1	107.7	-32.3
1	2004	35.2	104.8	0.0		140.0					0.0	140.0	76.7	17.6	0.7	0.7	13.2	108.9	-31.1
2	2005	15.3	31.3	0.0		46.6	9.6	8.9			18.5	65.1	78.4	17.6	0.7	0.7	13.4	110.7	45.6
3	2006			5.9	4.3	10.2	55.6	111.8			167.4	177.6	80.2	17.5	0.7	0.7	13.7	112.8	-64.8
4	2007			5.9	4.3	10.2	54.7	112.2			166.9	177.1	83.3	17.5	0.7	0.7	14.1	116.4	-60.7
5	2008			5.9	4.3	10.2	28.8	58.1			86.9	97.1	87.4	17.4	0.8	0.8	14.6	120.9	23.8
6	2009			5.9	4.3	10.2			0.2	3.7	3.9	14.1	91.3	17.4	0.8	0.8	15.1	125.3	111.2
7	2010			5.9	4.3	10.2			0.2	3.7	3.9	14.1	94.4	17.1	0.8	0.8	15.5	128.7	114.6
8	2011			5.9	4.3	10.2			0.2	3.7	3.9	14.1	97.4	17.1	0.8	0.9	15.9	132.2	118.1
9	2012			5.9	4.3	10.2			0.2	3.7	3.9	14.1	100.6	17.1	0.9	0.9	16.3	135.8	121.7
10	2013			5.9	4.3	10.2			0.2	3.7	3.9	14.1	103.8	17.1	0.9	0.9	16.7	139.4	125.3
11	2014			5.9	4.3	10.2			0.2	3.7	3.9	14.1	107.1	17.1	0.9	0.9	17.2	143.2	129.1
12	2015			5.9	4.3	10.2			0.2	3.7	3.9	14.1	110.5	17.1	1.0	1.0	17.6	147.2	133.1
13	2016			5.9	4.3	10.2			0.2	3.7	3.9	14.1	114.1	17.1	1.0	1.0	18.0	151.2	137.1
14	2017			5.9	4.3	10.2			0.2	3.7	3.9	14.1	117.7	17.1	1.0	1.0	18.5	155.4	141.3
15	2018			5.9	4.3	10.2			0.2	3.7	3.9	14.1	121.5	17.1	1.1	1.1	18.9	159.7	145.6
16	2019			5.9	4.3	10.2			0.2	3.7	3.9	14.1	125.4	17.1	1.1	1.1	19.4	164.1	150.0
17	2020			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.3	1.3	22.0	188.4	174.3
18	2021			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
19	2022			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
20	2023			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
21	2024			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
22	2025			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
23	2026			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
24	2027			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
25	2028			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
26	2029			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
27	2030			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
28	2031			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
29	2032			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
30	2033			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
31	2034			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
32	2035			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
33	2036			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
34	2037			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
35	2038			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
36	2039			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
37	2040			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
38	2041			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
39	2042			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
40	2043			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
41	2044			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
42	2045			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
43	2046			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
44	2047			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
45	2048			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
46	2049			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
47	2050			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
48	2051			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
49	2052			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
50	2053			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
51	2054			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
52	2055			5.9	4.3	10.2			0.2	3.7	3.9	14.1	146.8	17.1	1.2	1.3	22.0	188.4	174.3
Total		152.7	518.4	295.0	103.2	1,069.3	148.7	291.0	9.4	88.8	623.0	1,804.1						9,150.1	7,346.0
In the condition of discount rate at 10%:																			
Net Present Value (NPV):												776.2						1,106.4	330.1
Internal Rate of Return (EIRR):																			15.54%
B/C																			1.43



Construction (development) budget of branch offices of the Central Governmnt is used for development projects in Ho Chi Minh City directly managed by the Central Governmnt, and that of Ho Chi Minh City is used for development projects directly managed by the City. Therefore, whole amount of these two budget is for the total development budget for the project located in the Ho Chi Minh City.

Source : Statistical Yearbook, 1997, Ho Chi Minh City Service of Culture and Information, January 1998.

Fig. 15.1 Expenditure Mechanism in Budget for Ho Chi Minh City

Chapter 16
WATER ENVIRONMENT IMPROVEMENT

CHAPTER16 WATER ENVIRONMENT IMPROVEMENT

16.1 General

This section describes the prediction of future river/canal water quality and evaluation of sewerage development project and canal improvement project.
Simulation model was constructed based on the existing hydraulic and water quality condition. By using this simulation model, future river/canal water quality improvement is predicted, and projects that mentioned above are evaluated.

16.2 Pollution Load Generation

Pollution load generation was estimated in the previous study, namely the Study on Urban Drainage and Sewerage System for Ho Chi Minh City in the Socialist Republic of Viet Nam (JICA). Based on the pollution load generation in previous study and ratio of catchment area, pollution load generation in the basin of objective water bodies is estimated. Estimated wastewater and pollution load in each catchment area are shown in Table 16.1 and Fig. 16.1.

Existing and future (2010) pollution load generation as BOD in the catchment areas of inner city canals, namely Tau Hu-Ben Nghe, Doi-Te, Ong Lon and part of Sai Gon River, Xom Cui and Ba Lon canals, are estimated at approximately 88,500 kg/day and 113,700 kg/day, respectively. In the existing drainage condition, approximately 68,300 kg/day or 77 percent of pollution load generation in inner city canals is discharged into Tau Hu and Ben Nghe canals through the combined sewer system. Sewerage development in phase I covers the areas equal to 20 percent of pollution load generation in inner city canals, and in phase II, it covers the areas equal to 72 percent. Regional distribution of pollution load generation in the objective water bodies is shown in Fig. 16.2 (1/3) – 16.2 (3/3).

16.3 Existing Hydraulic and Water Quality Condition

Water quality survey in objective water bodies was carried out by JICA in 1998 and 1999. Using these results, outline of present water quality condition can be grasped. However, at the same time, the objective water bodies is highly influenced by the tidal effect, and it is difficult for water quality condition in the tidal water bodies to be grasped by single data. Therefore, continuous field survey is planned and carried out by JICA.
The hydraulic and water quality survey aims to investigate the existing hydraulic and water quality condition of river/canal in order to acquire basic data of simulation. Outline of hydraulic and water quality survey is described below.

(1) Outline of Hydraulic and Water Quality Survey

The survey was carried out from 31 May to 14 June 2000, and the survey period was fifteen (15) days. The survey consists of water level and flow measurement work, water sampling and water quality analysis work. The contents of survey are described below.

Objective water bodies and survey point:

- Saigon river (From the upper stream junction of Rach Ben Nghe to the down stream junction of Kinh Te)
- Canal networks: Tau Hu, Ben Nghe, Doi, Te, Ong Lon, Cay Kho, Tac Ben Ro, and Xom Cui.
- Survey point: 26 points in above-mentioned water bodies. (refer to Fig.16.3)

Water level and flow measurement work:

Water flow measurement was consisted of three (3) works.

- Cross- section of river/canal
- Water level measurement
- Water velocity and direction measurement

Water level and velocity measurement was carried out on the following conditions.

- Survey point: 26 points
- Survey period: 15 days continuously
- Frequency: Once every hour

Water sampling and water quality analysis work:

Water sampling and water quality analysis is carried out on the following conditions.

- Sampling point: 26 points
- Survey period: 15 days continuously
- Frequency of sampling: SS, BOD, Temperature ; 5 times at 5 hours interval
  COD, DO ; 3 times at 10, 15 and 20 o'clock
- Analyzed water quality parameter: BOD_5, COD_{Mn}, SS, Temperature and DO

(2) Existing Condition of Hydraulic and Water Quality (Results of Field Survey)

Based on the results of survey, characteristics of hydraulic and water quality conditions in the objective water bodies are summarized below. Results of water level, water flow measurement and water quality analysis are shown in Data Book, Water Quality Improvement of River and Canal.

<Hydraulic condition>

1) Variation of water level

The variations of water level at major investigation points are shown in Fig. 16.4. Maximum value at the maximum difference of water level by the tide during the

survey term is approximately 3.5 m in Cay Kho and Xom Cui canals. Minimum value at the maximum difference of water level is more than 2 m in the western part of Doi canal. It is found that the hydraulic condition of all objective water bodies is highly influenced by tidal effect.

2) Flow quantity and flow direction

Similarly, water flow quantity and flow direction in all of objective water bodies vary by tidal effect. Based on the survey results, water flow quantity and flow direction as an example is shown in Fig. 16.5.

3) Average water flow quantity

Based on the result of flow measurement, average water movement during survey term is estimated and shown in Fig. 16.6.

Based on the estimation, it is found that the water movement in Tau Hu and Ben Nghe canals is very small. Average water movement is estimated at 6 m^3/sec. (rising tide: 1 m^3/sec., ebb tide: 11 m^3/sec.) in Tau Hu (No.6) and 9 m^3/sec. (rising tide: 13 m^3/sec., ebb tide: 5 m^3/sec.) in Ben Nghe (No.11) respectively.

Tac Ben Ro canal as receiving water bodies from treatment plant has 60 m^3/sec. as the daily average water movement. Water movement in Ong Lon and Cay Kho canal ranges from 70 to 110 m^3/sec.

4) Relationship between flow quantity and difference of water level

According to the above mention, water flow in the objective water bodies is dominated by tidal effect. Based on the survey result, relationship between flow quantity and difference of water level between high and low tide at Phu An in Saigon River is estimated and shown in Fig. 16.7. It can be said that flow quantity is correlated closely with the difference of water level between high and low tide.

The difference of water level between high and low tide at Phu An during the survey term ranges from 1.1 m to 3.0 m. Average difference of water at Phu An from 1993 to 1997 ranges from 0.2 m to 3.0 m (refer to Fig. 16.8). From Fig. 16.8, it is found that observed water level covers about 75 % range of it at Phu An.

Consequently, from the above, it is considered that observed data covers yearly variation of water level and flow quantity.

5) Storage effect of river/canal water in swamp area

According to the field survey, the objective water bodies has large swamp area. It has become clear that some river/canal water is stored in swamp area on rising tide, and some water is supplied from swamp area on ebb tide. It is found that the storage effect is a considerable parameter for structure of simulation model.

6) Water exchange ratio in canal

According to the above mention at 1), the objective water bodies is characterized by large difference of water level between high and low tide. Similarly, it assumes that

a large water exchange in canal is occurred by tidal effect.
Then, water exchange ratio in canal is estimated and shown in Table 16.2.
It is well known that deterioration of water environment will be occurred under the condition of unsatisfactory water movement. However, the result of calculation shows a large water exchange ratio in canal as below.

Canal	Water exchange ratio
Tau Hu	72 %
Ben Nghe	76 %
Doi – Te	43 %
Ong Lon	48 %
Cay Kho	57 %
Tac Ben Ro	53 %
Xom Cui	61 %
Ba Lao	34 %

Note: water exchange ratio = [V1] / [V1+V2]
V1: canal water volume between high and low tide
V2: canal water volume at the low tide
Calculation condition: difference of water level between high and low tide is the median vale.

It is expected that desirable water environment condition will be kept after reduction of pollution load by the sewerage development project.

<Water quality condition>

1) Regional distribution of water quality (BOD, DO)
Regional distribution of water quality in river/canal is shown in Fig. 16.9. As for BOD, Lo Gom canal is most deteriorated canal in the objective water bodies with 76 mg/l as median and 366 mg/l as maximum during the survey term. Tau Hu, Ben Nghe, Doi and Te canals are deteriorated significantly. BOD concentration ranges from 11 mg/l to 69 mg/l as median and from 56 mg/l to 193 mg/l as maximum. On the other hand, canals in the southern part except a part of Ong Lon are slightly deteriorated with BOD concentration of less than 20 mg/l as median.

Similarly, regional distribution of dissolved oxygen (DO) is much the same as BOD (refer to Fig. 16.10). More than 2 mg/l as required DO value in the objective water bodies is provided in the Vietnam Standard (TCVN 5942-1995: Surface Water Quality Standard). Lo Gom, Tau Hu, Ben Nghe, Doi and Te canals, namely canals in the central city area, have the level of DO less than 2 mg/l as average.

Deterioration of canal water, namely BOD concentration is high, consumes dissolved oxygen. Consequently, it is well known that BOD value is inversely proportional to DO value. Based on the survey result, relationship between DO and

BOD value is estimated and shown in Fig. 16.11. It is found that water bodies of which BOD values less than 40 mg/l, have DO value more than 2 mg/l. It can be said that BOD value which is maintained under 25 g/l as the Surface Water Quality Standard (category B), satisfies provided DO value in the same standard.

2) Daily Variation of Water Quality by People's Activity

Generally, inflow water quality and quantity in wastewater treatment plant is changed by people's activity. Relationship between water quality (BOD) and sampling time is illustrated in Fig. 16.12 in order to verify variation of water quality in canal by people's activity. However, it is clear that similar situation in Tau Hu – Ben Nghe and Doi – Te canals was not verified. It is found that people's activity, namely daily variation of wastewater discharge is not remarkable.

3) Variation of Water Quality by Tidal Effect

As mentioned above, water change in river/canal is occurred by tidal effect. Similarly, it seems that variation of water quality is occurred by the change of river/canal water. Relationship between water quality and tidal is shown in Fig. 16.13. Based on this figure, it has become clear that variation of water quality is occurred by tide in some points in the canal. Especially, Doi – Te canal and the down stream of Ben Nghe canal is highly influenced by the change of river/canal water.

4) Influence of rainfall on water quality of river/canal

Variation of water quality and precipitation during the survey term are shown in Fig. 16.14. For the purpose of analyzing the water quality, Survey Data and the term are selected as from 31 May to 5th June, 2000. Survey point of No.6 and No. 8 in Tau Hu canal is selected as most affected point by discharged rainwater. From Fig. 16.14, it is clear that effect of discharged rainwater for water quality in canal is not remarkable.

5) The meaning of observed water quality during 15 days continuously survey

It can be roughly said that the observed water quality represented water quality in river/canal throughout the year.

Main parameters for control of water quality are listed below.

a. amount of pollution load generation
b. water movement
c. run-off and purification
d. others (people's activity, rainfall, etc)

Assuming that the amount of pollution load generation is fixed, water movement is most effective parameter for water control. From the above mentioned, assuming that observed water movement during the survey term also represented yearly water movement in the objective water bodies.

Run-off of pollution load depends on the development condition and drainage

system of the area. Purification in river/canal also depends on the canal condition. Therefore, run-off and purification are stable parameter.
Consequently, it can be said that the observed water quality represents water quality in river/canal throughout the year.

16.4 Modeling of Hydraulic and Water Quality Simulation

(1) Considerable Characteristic Condition for Simulation Model

According to the consideration of existing condition, considerable characteristics of hydraulic and water quality in construction of simulation model are listed below.

< Characteristics of hydraulic >
- The objective water bodies are highly influenced by tidal effect.
- Consequently, water level changes in a large.
- Similarly, flow direction and quantity vary hourly.
- Flow quantity is mostly controlled by tide.

< Characteristics of Water quality >
- Sources of pollution load converge in the city area.
- Similarly, significantly deteriorated water bodies are limited in the above area.
- Causes of polluted water bodies are classified into two items; one is mainly polluted by pollution load from catchment area, and another is polluted by river/canal water from significantly deteriorated water bodies.

(2) Construction of Simulation Model

Taking the results of data collection, field investigation and above characteristics of the objective water bodies into consideration, hydrodynamic and water quality simulation model is constructed.

It is known that for water quality problem in river/canal network, the one-dimensional mathematical model is often used and of which the hydrodynamic component (velocity field) is considered given from the hydraulic model using the following one-dimension Saint-Venant equations:

Continuity equation:

$$B\frac{\partial H}{\partial t} + \frac{\partial Q}{\partial x} = q \qquad (1)$$

Momentum equation:

$$\frac{\partial Q}{\partial t} + \frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right) + gA\frac{\partial H}{\partial x} + \frac{gQ|Q|}{AC^2R} = 0 \qquad (2)$$

Where
H: water level (m);
Q: discharge (m^3/sec.);
B: width at the water surface of river crossing section including average storage for each segment (m);
A: cross section area (m^2)
C: Chevy constant;
g: acceleration due to gravity (m/s^2)
R: hydraulic radius (m);
q: lateral in/out flow per unit length (m^2/s)
t: time (s)
x: distance along the canal (m)

Equations (1) and (2) are solved numerically by Pressann implicit finite different scheme and of which the solutions are H, Q, A and velocity.

The variation of BOD and DO in the river is mathematically described by the following transport-dispersion equations:

For BOD with concentration B:

$$\frac{\partial B}{\partial t} + U\frac{\partial B}{\partial x} = E\frac{\partial^2 B}{\partial x^2} - (K_1 + K_3 + \frac{q}{A})B + \frac{q}{A}B_q \qquad (3)$$

For DO with concentration D:

$$\frac{\partial D}{\partial t} + U\frac{\partial D}{\partial x} = E\frac{\partial^2 D}{\partial x^2} + K_2(D_s - D) - K_1 B - \frac{q}{A}D + \frac{q}{A}D_q \qquad (4)$$

Where;
Bq, Dq: Concentration of BOD and DO, respectively, in lateral flow q
Ds: saturation concentration of dissolved oxygen in the water
K_1: BOD removal rate constant
K_2: re-aeration constant
K_3: BOD removal constant due to settling
U: mean river flow velocity
E: longitudinal dispersion coefficient

Saturation concentration of dissolved oxygen in the water (Ds)

In general, Ds is a function of temperature and defined by the following empirical formula:

Ds = 475 / (33.5 + T)

Where;
T: stream water temperature (^oC)

Re-aeration constant (K2)

The coefficient K_2 is usually a function of stream velocity and stream depth. One of the empirical formulas for K_2 is given by the following Bennett and Rathbun equation:

$$K_2 = 2.33 \frac{U^{0.674}}{h^{1.865}}$$

Where;
U: mean velocity (m/sec.)
H: mean depth (m)
K_2: (1/day)

BOD removal rate constant (K_1)

One empirical formula for K_1 proposed by Wrigh and McDonnel [1)] is:

$K1 = 99.3\ Q^{-0.49}$ (1/day)[1)]

Both K_1 and K_2 are functions of temperature. Q (m^3/hr) is flow discharge.

The self-purification constant F is defined by the ratio:

$$f = \frac{K2}{K1}$$

It should be noted that although K_2 and K_1 depend on temperature, their ratio, f, is much less temperature dependent.

It is noted that in (3) if $K_1 = K_3 = 0$ one has a equation expressing salinity.
The equations (3) – (4) correspond to a general from:

[1)] "Assessment of Sources of Air, Water and Land Pollution" WHO, Genova, 1993

$$\frac{\partial S}{\partial t} + U\frac{\partial S}{\partial x} = E\frac{\partial^2 S}{\partial x^2} - \sigma S + \varphi \qquad (5)$$

where:
$\sigma > 0$ and φ are known coefficients;
S: concentration of BOD or DO (or salinity).

Equation (5) is solved numerically by the two-step method in which during one time step, firstly, the pure transport equation

$$\frac{\partial S}{\partial t} + U\frac{\partial S}{\partial x} = -\sigma S + \varphi \qquad (6)$$

is solved, of which along the characteristic line dx/dt = U solutions are:

$$S = \left(S_0 - \frac{\varphi}{\sigma} \right) e^{-\sigma t} + \frac{\varphi}{\sigma} \qquad (7)$$

where So is concentration at characteristic line foot. The next procedure is completed by solving the pure dispersion equation:

$$\frac{\partial S}{\partial t} = E\frac{\partial^2 S}{\partial x^2} \qquad (8)$$

By this two step procedure the solutions of (5) are found for each time step ®t.

16.5 Simulation of the Present Condition

(1) Basic Concept

Objective water bodies

Objective water bodies are determined for project evaluation as below.

- Objective water bodies in Saigon River are chosen from the upper stream of the junction of Ben Nghe canal to the down stream of the junction of Te canal.
- Canal networks: Tau Hu, Ben Nghe, Doi, Te, Ong Lon, Cay Kho, Tac Ben Ro, Xom Cui and Ba Lao canals.

It is necessary to select suitable boundary condition points for hydraulic and water

quality simulation. Based on the characteristics of hydraulic and water quality in the objective water bodies, sphere of water bodies for calculation and suitable boundary points are selected as below.

<Hydraulic Simulation>
The objective water bodies are organized by Dong Nai - Saigon river and Nha Be river system, and their hydraulic conditions are affected by hydraulic condition of the whole river system. Therefore, it is desirable that hydraulic simulation model in the objective water bodies is constructed under the whole river system.
Since 1992, Sub-institute developed the hydraulic simulation model in the whole river system of Saigon, Dong Nai and Nha Be rivers for Water Resource Planning [2)]. This simulation model is the same as the above mathematical model. Accordingly, in this hydraulic simulation will be carried out using the above simulation model. However, the condition of the objective water bodies is readjusted by the detailed survey in this study. Hydraulic schematization and points of boundary condition are shown in Fig. 16.15.

<Water Quality Simulation>
Based on the results of water quality survey, discharged wastewater in inner city area affects water quality in even Cay Kho and Ba Lao canals. Therefore, water bodies having stable water quality should be defined as the boundary of simulation model. Four rivers, namely Saigon river, Nha Be river, Cho Dem canal and Can Gluoc canal, are boundaries of water quality simulation model and are shown in Fig. 16.16.

(2) Calculation Condition

Cross section of river/canal
Cross section of river/canal in the objective water bodies is shown in Data Book, Water Quality Improvement of River and Canal.

Pollution load generation and run-off
Existing and future pollution load generation in catchment area and its discharged point are shown in Table 16.1, Fig.16.1.
Run-off in pollution load is assumed below.

Objective catchment area	Run-off
Inner city area	1.0
Rural area	0.1

[2)] i: Water Resources Planning Project on Area Networks West and East Vam Co River - Hydraulic report- Sub-Institute of Water Resources Planning, 1998.
ii: HCMC Urban Drainage – Hydraulic report – SIWRP, 1999.

It is assumed that catchment area in the objective water bodies is classified by two categories. One is developed area with drainage system and another is area without drainage system. Basically, the inner city area is developed with drainage pipe system. Therefore, assuming that all the discharged pollution load flow into the river/canal. And furthermore, most of households have treatment system for black water as septic tank. However, it seems that most of treatment facilities are occurred malfunction of treatment for the reason that facilities have not received maintenance as desludging or cleaning. Consequently, assuming that discharged pollution load is the same as pollution load generation.

On the other hand, wastewater in rural area flows into canal through natural drainage channel. Therefore, run-off ratio in rural area is 0.1 because wastewater is received due to the function of natural purification.

Rainfall and run-off

Rainfall observation points are located No.1, No.23, No.26 as temporary observing stations of hydraulic and water quality survey points and Tan Son Nhat as observatory in HCMC.

(3) Result of Calibrated Simulation

Using above simulation model, existing hydraulic and water quality (BOD) are simulated. As a result of calibration, comparison of observed data and simulated water level, water flow and water quality are shown in Fig. 16.17, Fig. 16.18, Fig. 16.19.

Judging from the above Figures, the simulation model is appropriate for the evaluation of water quality improvement by projects.

However, according to Fig. 16.19 as the result of water quality simulation, lack of calibration in simulation between observed and simulated water quality is found. Especially, simulated water quality in Doi canal (No. 9) is much different from the observed data. It can be assumed that the observed data was accidental fluctuation of water quality. This sharp fluctuation is also found in Tau Hu (No. 8), Doi (No.7), Ong Lon (No.10) and Tac Ben Ro (No.17) in the same time. Consequently, assuming that this fluctuation during 3rd to 4th August is unusual water condition, calibration of water quality simulation is carried out except observed data during 3rd to 4th August.

16.6 Future Prediction of Hydraulic and Water Quality Condition

(1) Prediction Condition

Prediction conditions for future water quality are selected as below. Treated wastewater from the proposed wastewater treatment plant discharge into Tac Ben Ro canal.

Case	Target year	Canal Improvement	Sewerage Development Area	Treated Wastewater of wastewater Treatment Plant	
Case - 1	2005	Existing	Non	Non	
Case - 2	2010	Existing	Non	Non	
Case - 3	2005	Existing	Phase I	50 mg/l –BOD	1.63 m^3/sec.
Case - 4	2005	Phase I	Phase I	50 mg/l –BOD	1.63 m^3/sec.
Case - 5	2010	Phase II	Phase II	50 mg/l –BOD	5.43 m^3/sec.
Case – 6*	2010	Phase II	Phase II	50 mg/l –BOD	5.43 m^3/sec.
Case – 7*	2010	Phase II	Final Phase	20 mg/l –BOD	5.43 m^3/sec.

Note * : Assuming that water quality in Lo Gom canal is 25 mg/l.

(2) Result of Future Prediction

Future water quality condition is predicted and shown in Table 16.3 and Fig. 16.20. In Table 16.3, predicted water quality means 75-percentile value. When environmental condition and environment improvement project will be evaluated, representative water quality value should be used. If maximum observed water quality is selected as the representative water quality, the project cost will be huge. On the other hand, if the median value is selected, the improved river/canal water quality will be maintained below the target water quality only a half of year. In case of Japan, considering the cost and benefit, 75-percentile value is adopted for evaluation of environment condition and its project. Consequently, representative water quality value in this study is decided of 75-percentile value as same as Japan.

Case-1 and Case-2 (without Projects of 2005 and 2010)

Water quality in 2005 and 2010 without project increases approximately 1.4 times and 1.6 times of the existing water quality respectively.

Under the condition of no countermeasures, water quality of rivers/canals in the inner city will be more deteriorated. Furthermore, water quality of canals in the southern area, namely Ong Lon and Xom Cui canal will be also seriously deteriorated.

Case-3 (Phase I : Sewerage development, 2005)

As a result of the reduction of pollution load by sewerage system (phase I), water quality in Tau Hu-Ben Nghe canal and Doi-Te canal will be slightly improved. However, water quality of Tau Hu canal is not satisfied yet with BOD concentration ranging from 70 mg/l to 107 mg/l. While, water quality of Ben Nghe canal is drastically improved because of that the almost wastewater from its catchment area is intercepted by interceptor sewer.

Case-4 (Phase I : Sewerage development + Canal improvement, 2005)

As a result of Tau Hu and Ben Nghe canal improvement, water quality of the middle

and down stream of Tau Hu canal is improved. However, the rate of water quality improvement is approximately 12 percent of its original water quality. It can be said that the reduction of pollution load is more effective measures than canal improvement for canal water quality improvement in the inner city area.

Case-5 (Phase II : Sewerage development + Canal improvement, 2010)
The contribution of sewerage system (phase II) to canal water quality improvement is prominent. As a result of the execution of phase II project of sewerage development, water quality of the objective water bodies except a part of Tau Hu and Doi canal is improved dramatically. Moreover, Tac Ben Ro canal receiving water bodies of treated water from wastewater treatment plant still maintains its water quality below the permissible level stipulated in Vietnamese water environmental standards.

Case-6 (Case-5 + Improvement of Lo Gom water quality(25 mg/l BOD), 2020)
In case 5, future water quality in Tau Hu (from upper to middle reaches) and Doi (from middle to lower reaches) canal is predicted from 27 mg/l to 55 mg/l in BOD. These insufficient improvement of water quality are caused by pollutant discharged from Lo Gom canal. From this point, water quality improvement project for Lo Gom canal is also required to maintain the water quality of canals in the project area in the satisfied level. Consequently, sewerage development of Tan Hoa-Lo Gom area studying by PMU 415 should be implemented simultaneously with this project to achieve the desirable water environment.

Case-7 (Final phase : Sewerage develop., treatment level = 20 mg/l-BOD, 2010)
As a result of the improvement of treatment level in wastewater treatment plant, further water quality in all the objective water bodies is estimated.

16.7 Evaluation

(1) Desirable Water Environment Condition (The Environment Standard)

Desirable water environment condition is provided in the Vietnam Standard (TCVN 5942-1995: Surface Water Quality Standard). According to the Vietnam Standard, desirable water environment condition in the objective water bodies is suitable for category B, and BOD concentration less than 25 mg/l is applied. Therefore, future water quality in all of object water bodies is desired to improve the water quality in order that it is less than 25 mg/l in BOD.

(2) Effectiveness of Water Quality Improvement by Projects

It is thought that project evaluation is estimated by the difference between without project and with project in the same year. Effectiveness of water quality improvement by project

is shown in Fig. 16.21.
From Fig. 16.21, it can be said that canal improvement and sewerage development projects have a significant role for water quality improvement in objective water bodies of HCMC.

However, water quality improvement in all of objective water bodies is not satisfied by the above projects. Future water quality in Tau Hu (from upper to middle reaches) and Doi (from middle to lower reaches) canals is predicted from 27 mg/l to 55 mg/l in BOD. This insufficient improvement of water quality is caused by polluted canal water from Lo Gom canal. If water quality in Lo Gom canal will be improved by execution of environment improvement project in Tan Hoa-Lo Gom area, water quality in all of objective water bodies is predicted less than 16 mg/l in BOD.

From the point of view of achievement and preservation of desirable water environment condition, it is necessary to carry out the Sewerage Development Project in THBNDT, Tau Hu – Ben Nghe Canal Improvement Project and measures for water quality improvement for Lo Gom canal.

Water quality of Tac Ben Ro canal, the receiving water bodies of treated water from treatment plant is estimated as below.

Case	volume of wastewater	Predicted water quality (mg/l-BOD) median	75 %*	maximum
Existing (2000)	-	11	19	39
Phase I Project (2005)	1.63 m^3/sec.	13	20	41
Phase II Project (2010)	5.43 m^3/sec.	11	14	25

*: 75-percentile value

The 75-percentile value is applied as a parameter for evaluation of water environment condition. The water quality of Tac Ben Ro canal in 2005 is not deteriorated and can be preserved desirable water environment condition.
Moreover, its water quality in 2010 will be improved more by Phase II sewerage development project. It is concluded that water quality of Tac Ben Ro canal will not be aggravated by discharged water from the proposed wastewater treatment plant.

TABLE 16.1 WASTEWATER AND POLLUTION LOAD GENERATION IN EACH RIVER/CANAL

River/canal	Catchment Area (ha)	Wastewater Generation (m^3/day)				Pollution Load Generation (kg/day)				PLG after SD (kg/day) (*)	
		1997	2000	2005	2010	1997	2000	2005	2010	Phase-1(*)	Phase-2(*)
TOTAL	**20,208.45**	**366,645**	**439,863**	**587,394**	**696,559**	**86,784**	**96,676**	**117,320**	**133,269**	**96,296**	**51,160**
Inner city canals**	**6,868**	**345,477**	**406,126**	**526,924**	**606,920**	**81,364**	**88,468**	**103,633**	**113,703**	**82,610**	**31,896**
Others	**13,340.65**	**21,169**	**33,738**	**60,471**	**89,639**	**5,420**	**8,208**	**13,687**	**19,566**	**13,687**	**19,264**
1- Sai Gon	***1239.82***	***12,662***	***15,926***	***22,833***	***29,071***	***3,033***	***3,538***	***4,537***	***5,430***	***2,788***	***2,516***
.Sai Gon_1	212.55	5,876	6,893	8,917	10,238	1,383	1,499	1,749	1,911	-	-
.Sai Gon_2	52.12	3,100	3,632	4,690	5,376	729	790	920	1,004	920	-
.Sai Gon_3	975.15	3,686	5,401	9,226	13,457	922	1,249	1,868	2,516	1,868	2,516
2-Ben Nghe	***529.00***	***49,989***	***58,362***	***74,897***	***85,297***	***11,762***	***12,694***	***14,691***	***15,922***	***5,397***	***-***
.Ben Nghe_1	380.01	31,844	37,084	47,385	53,726	7,493	8,066	9,295	10,029	-	-
.Ben Nghe_2	148.99	18,145	21,278	27,511	31,571	4,270	4,628	5,397	5,893	5,397	-
3-Tau Hu	***3134.84***	***218,075***	***255,861***	***331,106***	***380,293***	***51,314***	***55,652***	***64,955***	***70,998***	***54,975***	***28,448***
.Tau Hu_1	299.50	36,270	42,235	53,962	61,175	8,534	9,186	10,585	11,419	605	-
.Tau Hu_2	842.92	92,792	108,005	137,873	156,163	21,835	23,491	27,045	29,150	27,045	1,711
.Tau Hu_3	102.70	2,163	2,487	3,112	3,445	510	540	611	643	611	643
.Tau Hu_4	461.17	9,795	11,901	16,305	19,775	2,304	2,589	3,198	3,692	3,198	-
.Lo Gom	1428.56	77,056	91,234	119,854	139,735	18,132	19,846	23,516	26,093	23,516	26,093
4-Doi	***571.79***	***28,153***	***32,817***	***42,007***	***47,709***	***6,625***	***7,137***	***8,241***	***8,905***	***8,241***	***868***
.Doi_1	177.99	2,843	3,371	4,444	5,195	669	733	872	969	872	766
.Doi_2	228.06	13,316	15,472	19,695	22,242	3,133	3,365	3,864	4,152	3,864	101
.Doi_3	165.75	11,995	13,974	17,868	20,273	2,822	3,039	3,505	3,784	3,505	-
5-Te	***432.38***	***22,192***	***26,300***	***34,579***	***40,415***	***5,235***	***5,738***	***6,797***	***7,545***	***6,797***	***605***
6-Xom Cui	***735.09***	***4,319***	***5,412***	***7,619***	***9,466***	***1,036***	***1,221***	***1,600***	***1,946***	***1,600***	***609***
.Xom Cui_1	428.27	4,103	5,015	6,862	8,315	976	1,113	1,399	1,642	1,399	305
.Xom Cui_2	306.82	216	397	757	1,151	60	107	201	304	201	304
7-TacBenRo	***139.63***	***105***	***187***	***348***	***524***	***29***	***50***	***92***	***138***	***92***	***138***
8-OngLon	***882.25***	***13,484***	***16,380***	***22,292***	***26,935***	***3,200***	***3,612***	***4,463***	***5,158***	***4,463***	***1,052***
9-CayKho	***481.26***	***259.80***	***555.40***	***1149.40***	***1805.00***	***72.30***	***149.90***	***304.70***	***476.50***	***304.70***	***476.50***
10-Dia	***2129.85***	***5,614***	***8,498***	***14,831***	***21,832***	***1,415***	***1,999***	***3,116***	***4,299***	***3,116***	***4,299***
11-Phuoc Kien	***1615.62***	***873***	***1,864***	***3,859***	***6,059***	***243***	***504***	***1,023***	***1,599***	***1,023***	***1,599***
12-Ba Tang	***330.51***	***1,712***	***2,334***	***3,703***	***5,045***	***408***	***518***	***751***	***982***	***751***	***680***
13-Ba Lon	***624.60***	***506***	***865***	***1,575***	***2,343***	***141***	***234***	***418***	***619***	***418***	***619***
14-Ba Lao	***2274.57***	***1,689***	***3,018***	***5,659***	***8,530***	***469***	***815***	***1,501***	***2,252***	***1,501***	***2,252***
.Ba Lao_1	584.03	473	809	1,473	2,190	132	218	391	578	391	578
.Ba Lao_2	1690.54	1,216	2,210	4,187	6,340	338	597	1,110	1,674	1,110	1,674
15-Others	***5087.23***	***7,015***	***11,483***	***20,937***	***31,237***	***1,802***	***2,817***	***4,830***	***6,999***	***4,830***	***6,999***
.Tom	721.71	390	833	1,724	2,706	108	225	457	715	457	715
.Tom_1	417.39	225	481	997	1,565	63	130	264	413	264	413
.CanGiuoc	1122.34	1,519	2,446	4,405	6,505	390	602	1,032	1,493	1,032	1,493
R.DapOngHien	503.91	408	698	1,271	1,890	113	189	337	499	337	499
.Ben Luc	140.17	812	1,148	1,911	2,688	191	250	375	502	375	502
.NhaBe	2181.71	3,661	5,877	10,631	15,882	937	1,422	2,365	3,378	2,365	3,378

Note : (*) PLG after SD : Pollution Load Generation after Sewerage Development
(*) Phase_1 : Sewerage development Phase_1 with target year of 2005
(*) Phase_2 : Sewerage development Phase_2 with target year of 2010
(**) Inner city canals : Tau Hu-Ben Nghe, Doi - Te, Ong Lon, Xom Cui-1, Ba Lon Sai Gon-1 and Sai Gon-2

TABLE 16.2 WATER EXCHANGE RATIO IN RIVER/CANAL

unit : V1,V2 : x1000 m^3

River/canal	Difference of water level	V1	V2	(V1)/ (V1 + V2)
Tau Hu	Minimum	416	611	40%
	Median	691	270	72%
	Maximum	858	177	83%
Ben Nghe	Minimum	179	250	42%
	Median	306	96	76%
	Maximum	406	42	91%
Doi - Te	Minimum	1,209	4,164	23%
	Median	2,295	3,089	43%
	Maximum	2,907	2,463	54%
Ong Lon	Minimum	717	1,860	28%
	Median	1,175	1,294	48%
	Maximum	1,545	1,014	60%
Cay Kho	Minimum	351	706	33%
	Median	550	416	57%
	Maximum	761	301	72%
Tac Ben Ro	Minimum	183	353	34%
	Median	253	228	53%
	Maximum	340	165	67%
Xom Cui	Minimum	646	1,012	39%
	Median	885	556	61%
	Maximum	1,237	385	76%
Ba Lao	Minimum	334	1,041	24%
	Median	416	807	34%
	Maximum	716	642	53%

Note: Minimum : Minimum value of water level difference during survey period
Median : Median value of water level difference during survey period
Maximum : Maximum value of water level difference during survey period

Water exchange ratio = [V1] / [V1 + V2]

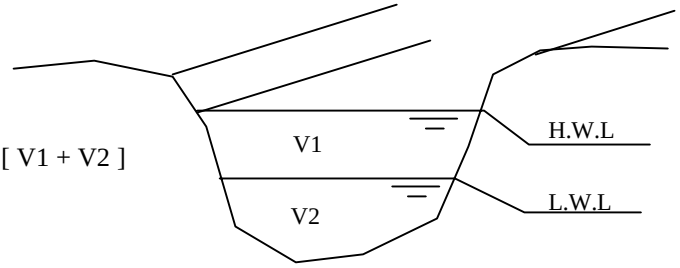


TABLE. 16.3 RESULT OF WATER QUALITY SIMULATION AND PREDICTION

unit : mg/l-BOD 75-percentile value

River/Canal Name	Point No.	Simulation (Existing)	Prediction of Future Water Quality						
			Case -1	Case -2	Case -3	Case -4	Case -5	Case -6	Case -7
Target year		2000	2005	2010	2005	2005	2010	2010	2010
Sewerage Development (Wastewater volume) (BOD in treated wastewater)		without	without	without	Phase I 141,000 m^3/day 50 mg/l	Phase I 141,000 m^3/day 50 mg/l	Phase II 469,000 m^3/day 50 mg/l	Phase II 469,000 m^3/day 50 mg/l	Final phase 469,000 m^3/day 20 mg/l
Canal Improvement		without	without	without	without	Phase I	Phase II	Phase II	Phase II
Lo Gom canal water quality condition		Existing condition	Existing condition	Existing condition	Existing condition	Existing condition	Existing condition	25 mg/l -BOD**	25 mg/l -BOD**
Tau Hu canal	3	73 (76)*	91	97	78	78	55	16	16
	6	105 (89)	149	163	107	94	40	12	11
	8	75 (75)	104	121	70	61	20	7	6
Ben Nghe canal	11	34 (42)	77	85	25	25	16	9	8
Doi canal	7	61 (71)	81	89	65	64	43	14	13
	9	46 (51)	62	69	45	43	27	9	9
Te canal	12	14 (22)	20	23	14	14	10	6	6
Ong Lon canal	10	44 (53)	63	73	44	42	24	9	8
	13	28 (33)	41	47	27	26	16	7	6
	15	19 (19)	26	30	18	17	12	6	5
Tac Ben Ro canal***	17	19 (19)	25	28	20	20	14	8	6
Xom Cui canal	19	29 (17)	40	45	30	30	18	7	6
Cay Kho canal	22	10 (16)	13	14	10	10	10	6	5
Ba Lao canal	23	11 (16)	14	15	10	10	10	6	5

* : ( ) is 75-percentile value in observed data.

** : Surface Water Quality Standard (TCVN 5942-1995, Category B)

*** : Tac Be Ro canal is receiving water bodies from sewerage treatment plant.

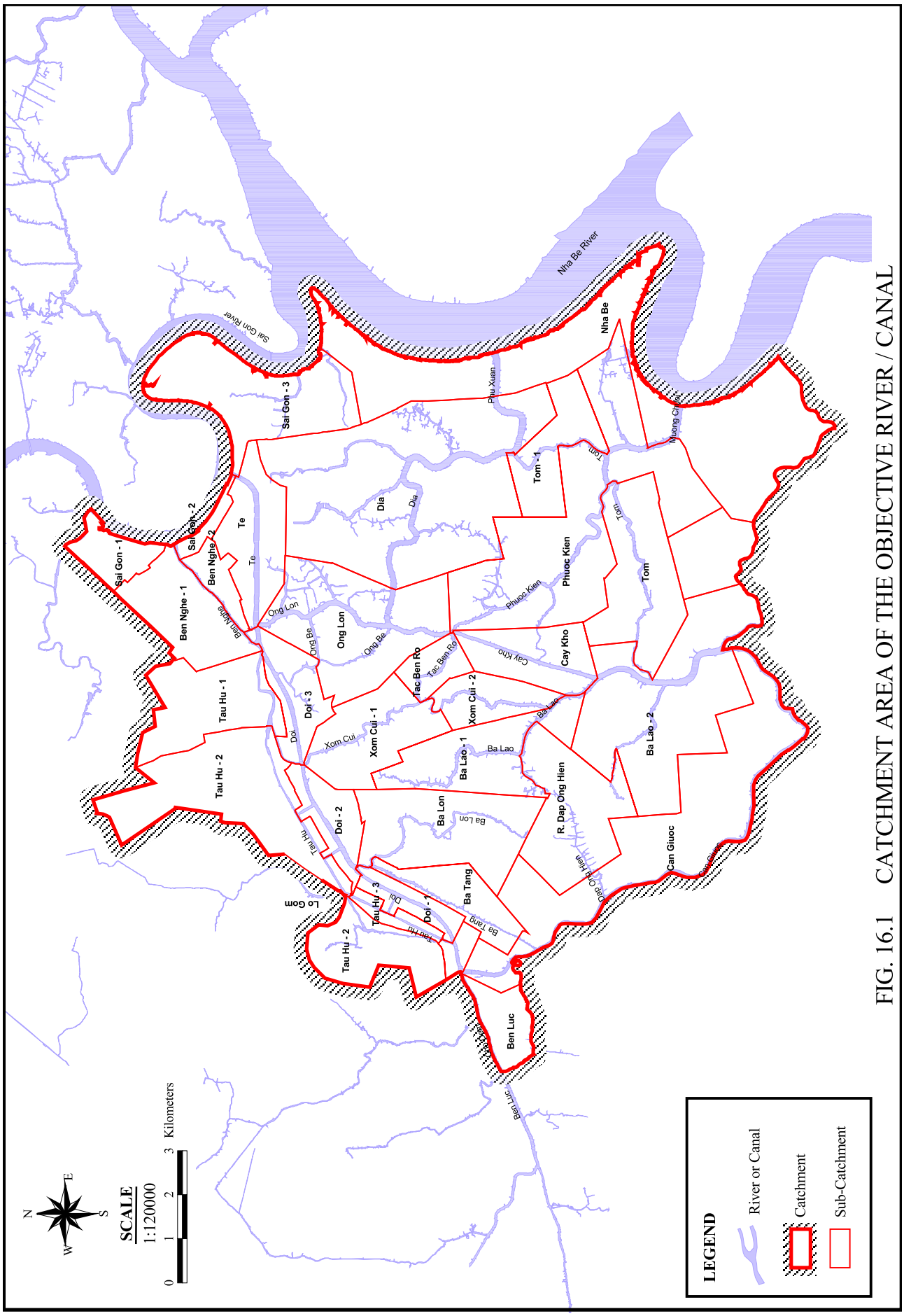


FIG. 16.1 CATCHMENT AREA OF THE OBJECTIVE RIVER / CANAL

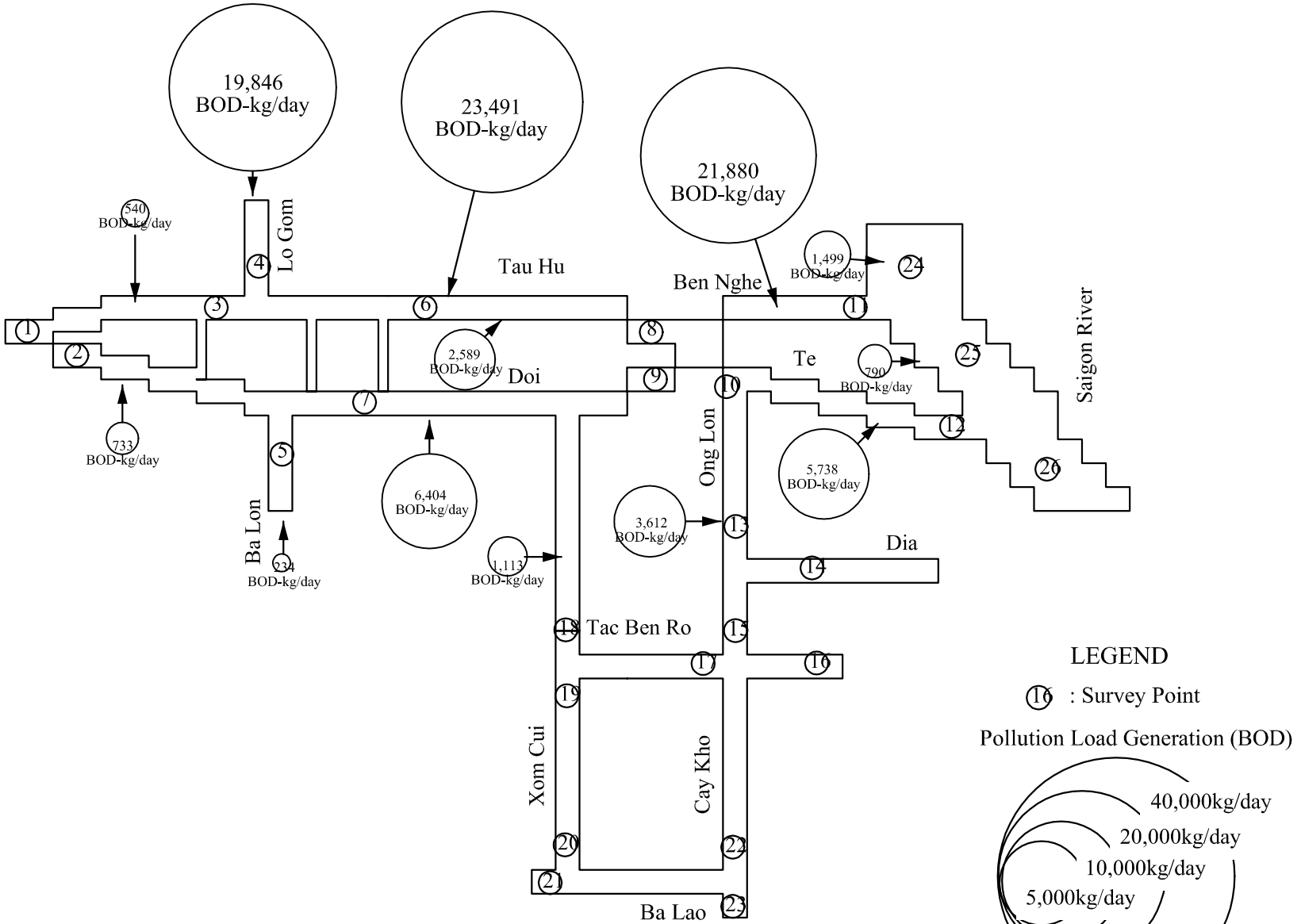


FIG. 16.2(1/3) REGIONAL DISTRIBUTION OF POLLUTION LOAD GENERATION (2000)

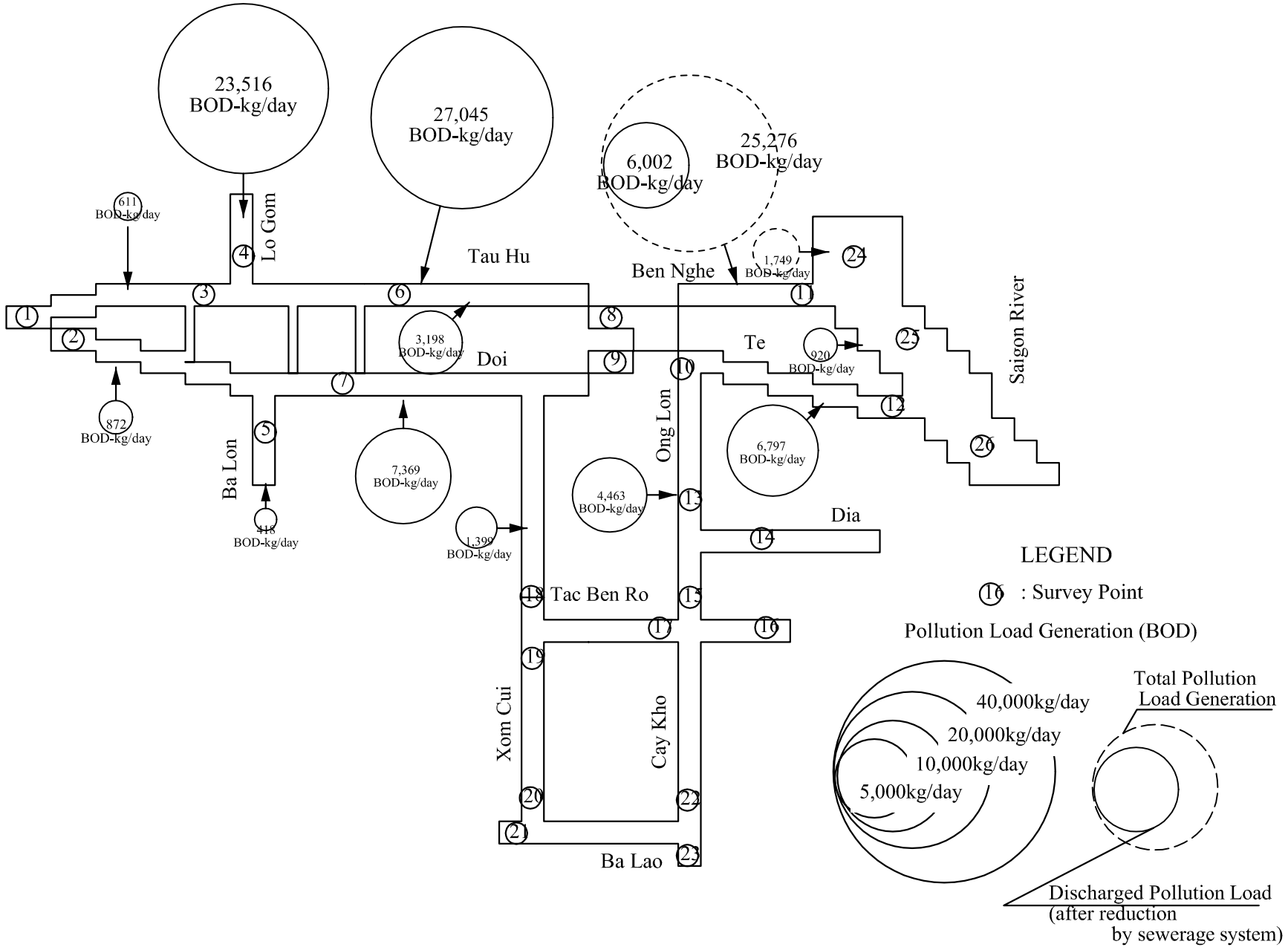


FIG. 16.2(2/3) REGIONAL DISTRIBUTION OF POLLUTION LOAD GENERATION (2005)

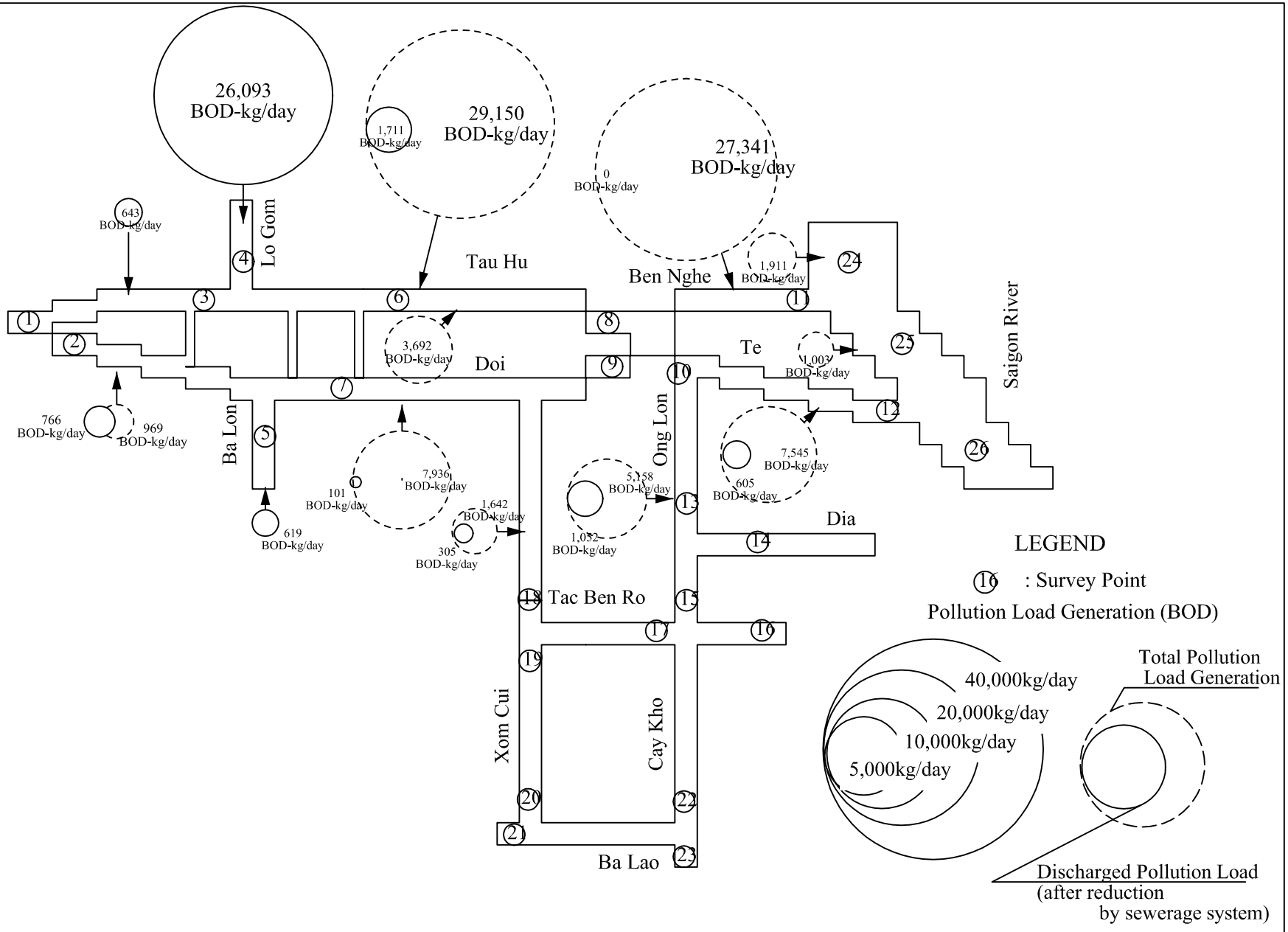


FIG. 16.2 (3/3) REGIONAL DISTRIBUTION OF POLLUTION LOAD GENERATION (2010)

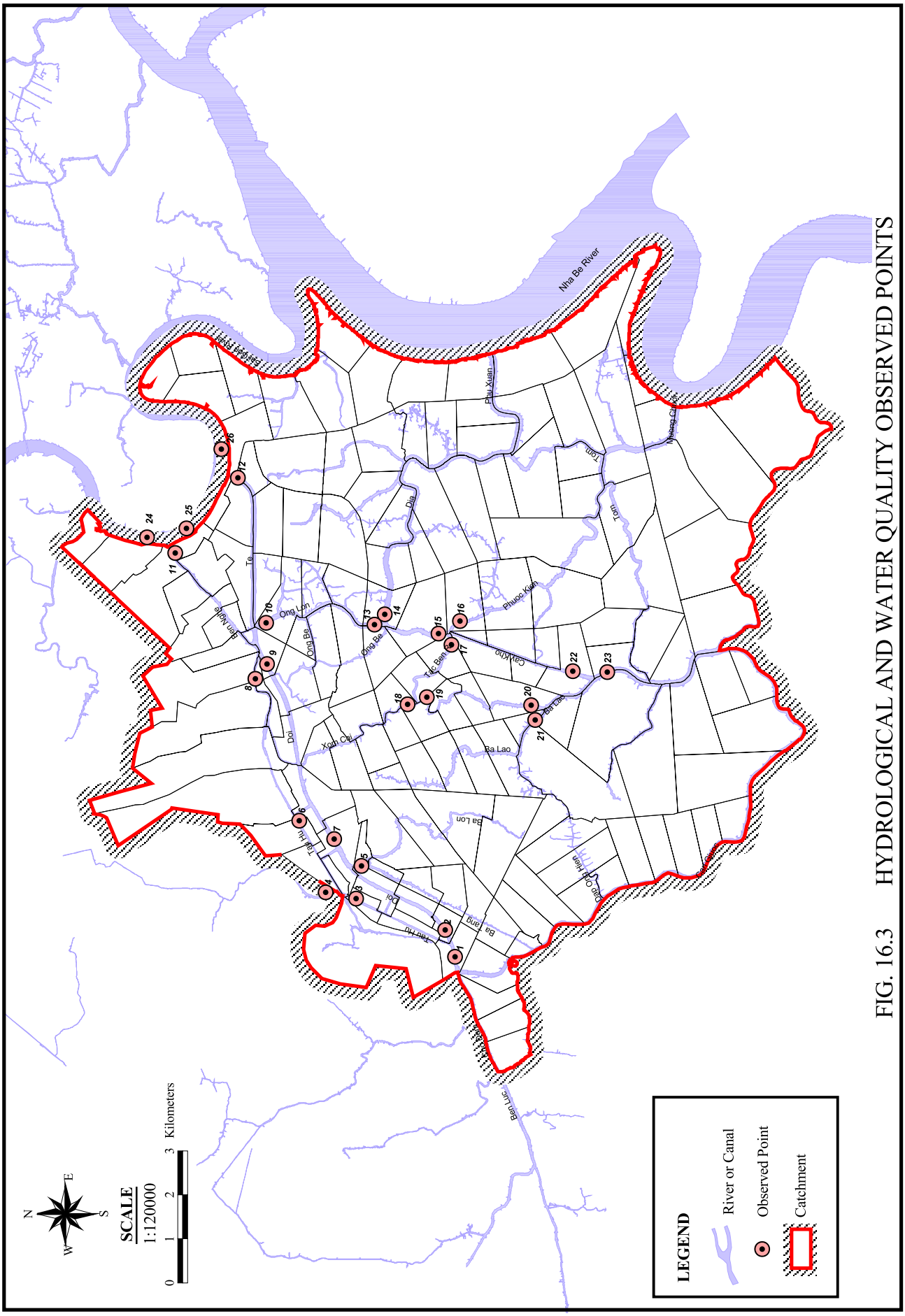


FIG. 16.3 HYDROLOGICAL AND WATER QUALITY OBSERVED POINTS

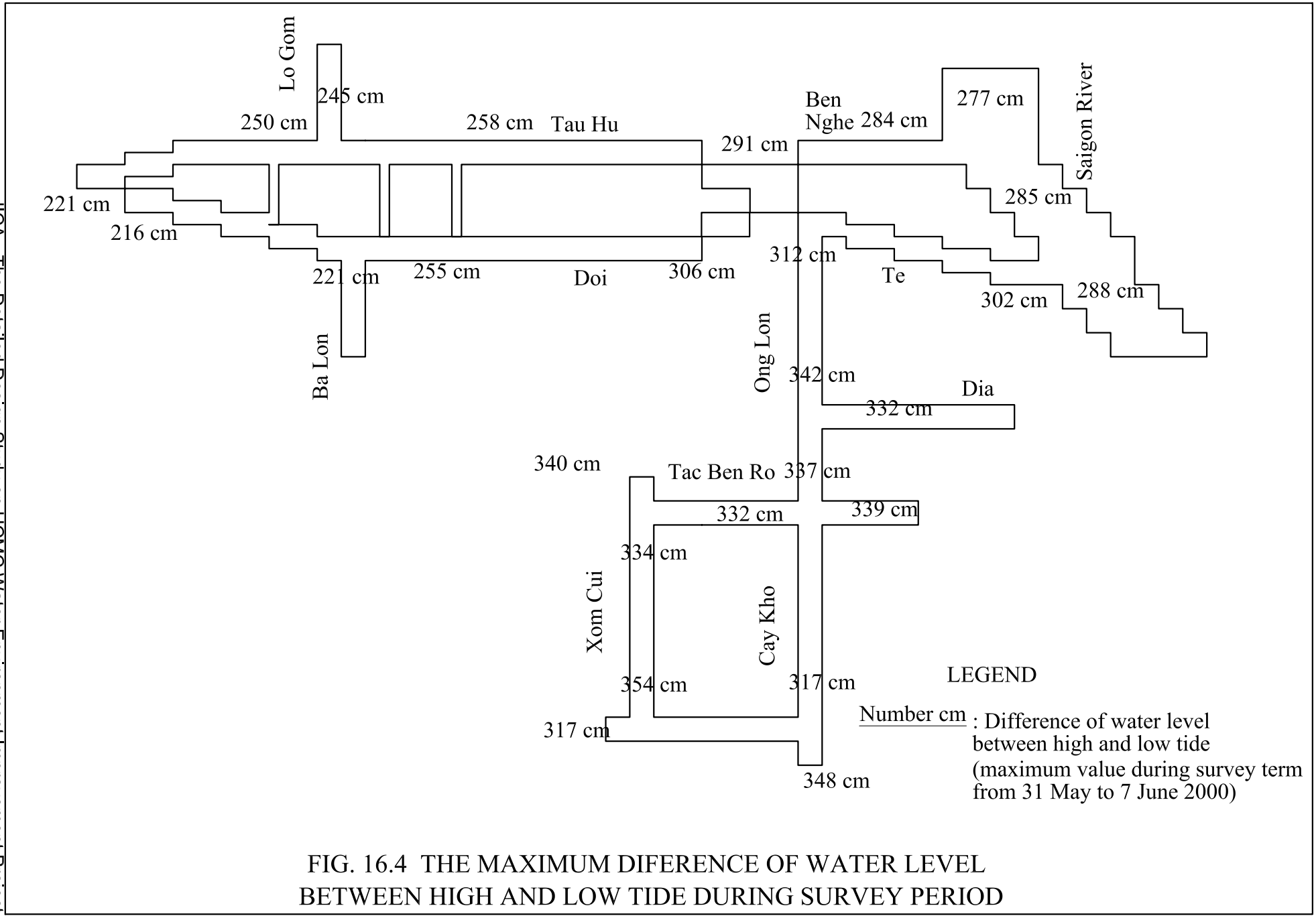


FIG. 16.4 THE MAXIMUM DIFERENCE OF WATER LEVEL BETWEEN HIGH AND LOW TIDE DURING SURVEY PERIOD

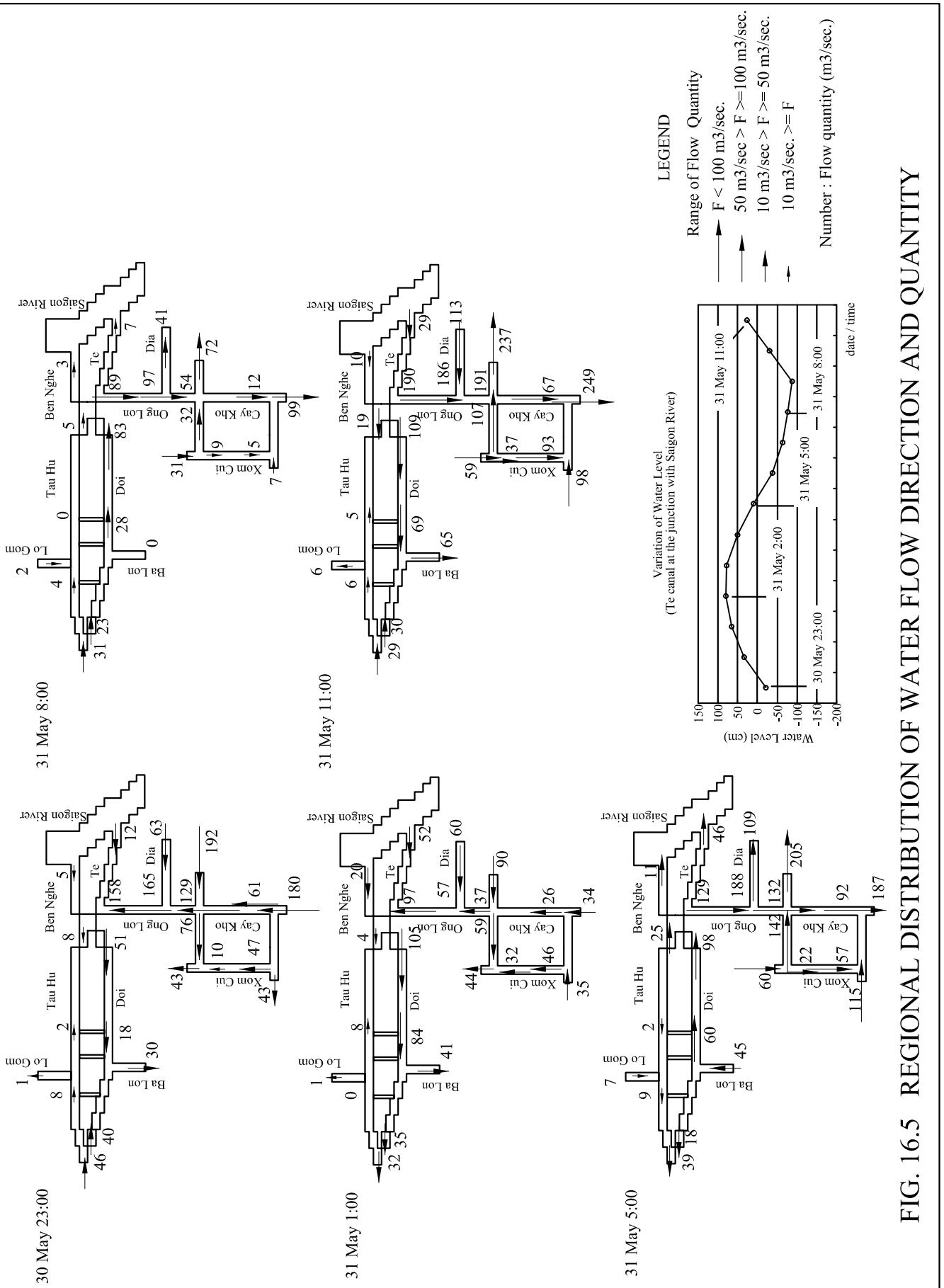


FIG. 16.5 REGIONAL DISTRIBUTION OF WATER FLOW DIRECTION AND QUANTITY

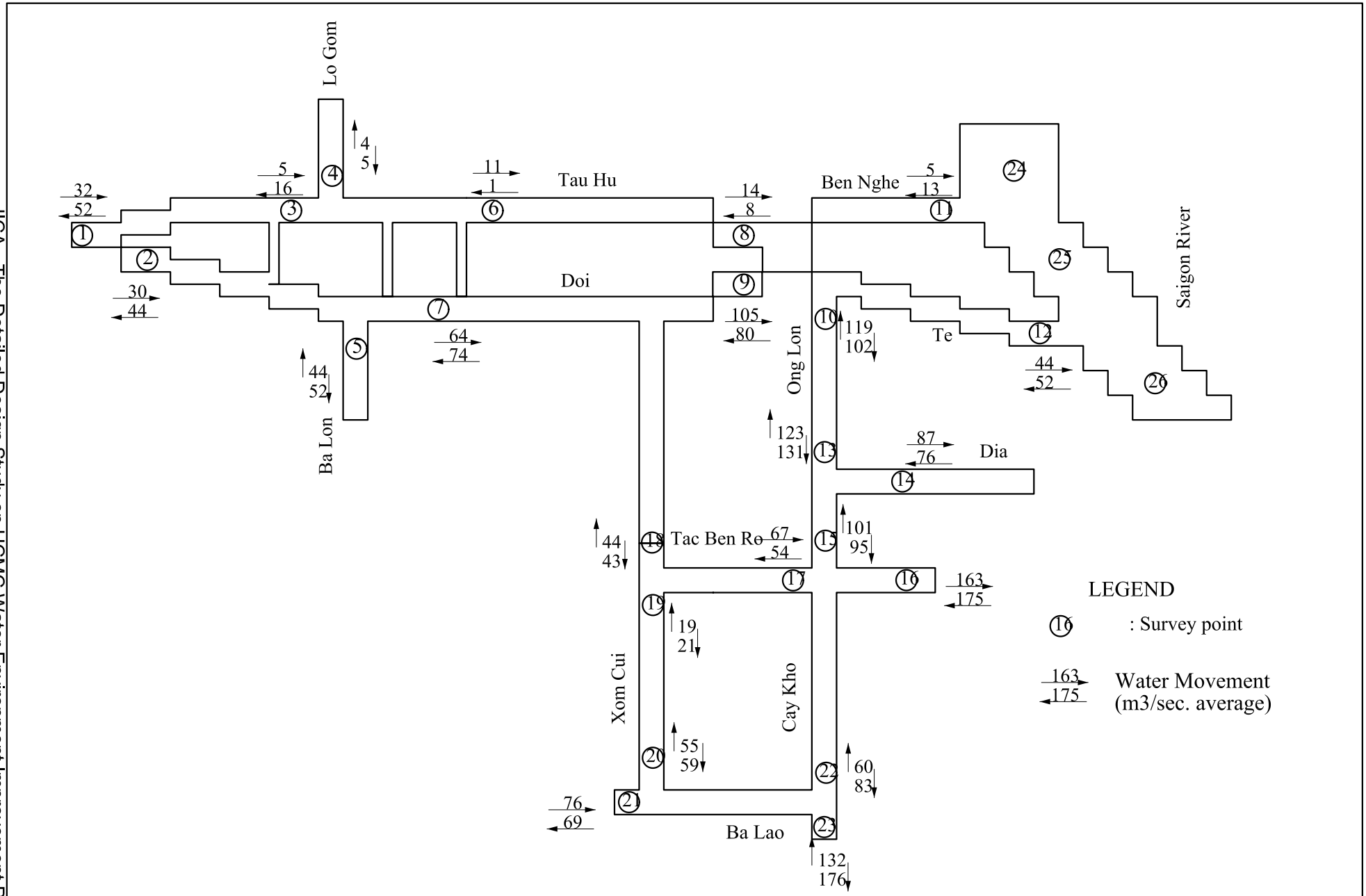
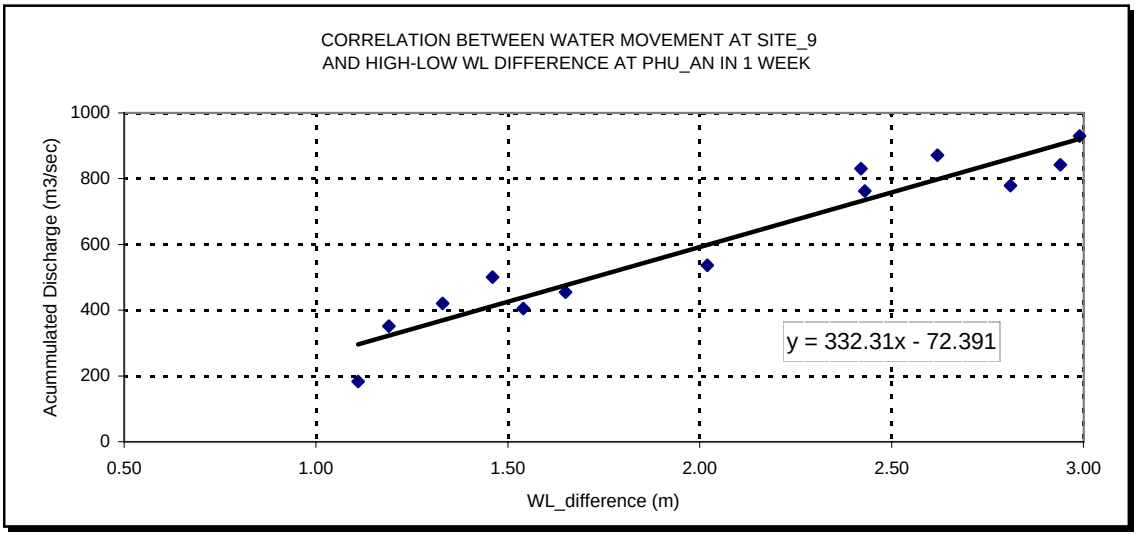
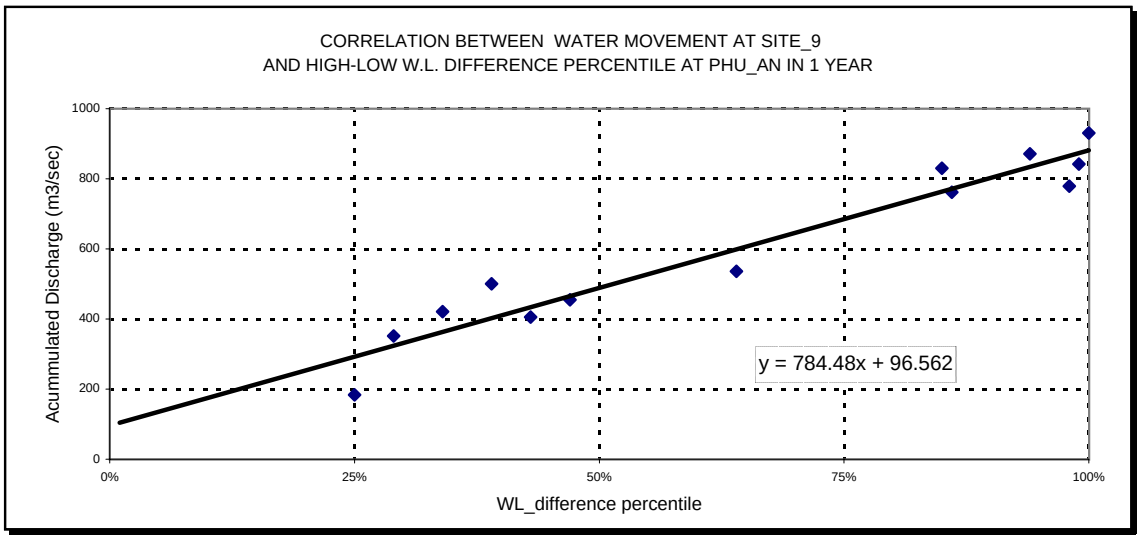


FIG. 16.6 REGIONAL DISTRIBUTION OF WATER MOVEMENT

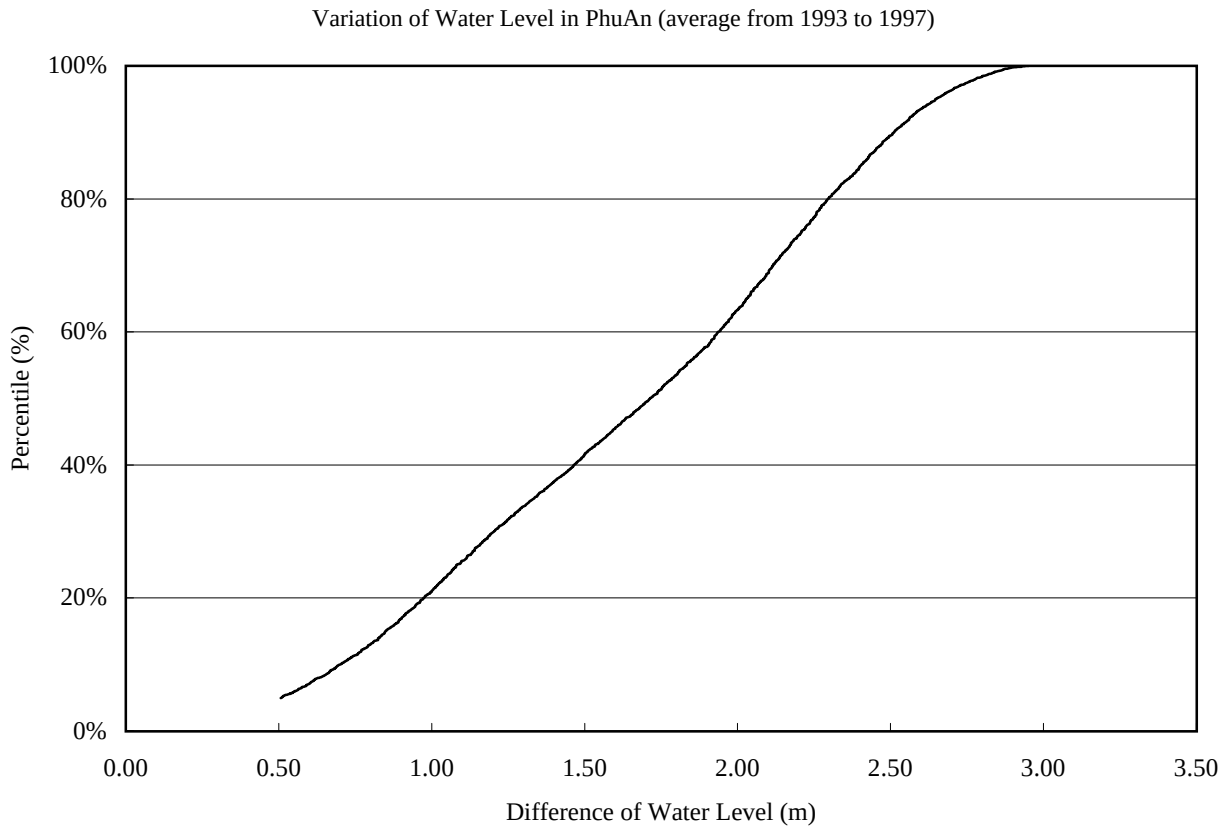




Date&Time	WL_1W Difference (m)	AWL_1Y Percentile (%)	Q_1W Acumulated (m3/sec.)
	(1)	(2)	(3)
1900/6/5 12:00	1.11	25%	183
1900/6/4 11:00	1.19	29%	351
1900/6/3 11:00	1.33	34%	421
1900/6/2 10:00	1.46	39%	501
1900/6/1 9:00	1.54	43%	406
1900/5/31 9:00	1.65	47%	455
1900/5/30 21:00	2.02	64%	536
1900/5/31 22:00	2.42	85%	831
1900/6/1 23:00	2.43	86%	762
1900/6/3 0:00	2.62	94%	871
1900/6/4 0:00	2.81	98%	779
1900/6/6 2:00	2.94	99%	842
1900/6/5 1:00	2.99	100%	930

Note :
(1) : Water level difference between high and low tide based on observed data in 1 week from 30 May to 06 June 2000
(2) : Average water level difference percentile in 1 year based on data from 1993-1997
(3) : Acummulated discharge at site_9 on Doi canal from high to low tide based on observed data in 1 week from 30 May to 06 June 2000

FIG. 16.7 RELATIONSHIP BETWEEN FLOW QUANTITY AND DIFFERENCE OF WATER LEVEL



No.	Percentile (%)	Water Level Difference					
		1993	1994	1995	1996	1997	Average
70	5%	0.34	0.48	0.52	0.57	0.62	0.51
142	10%	0.57	0.66	0.73	0.77	0.79	0.70
283	20%	0.86	0.95	0.99	1.02	1.05	0.97
707	50%	1.67	1.70	1.72	1.71	1.77	1.71
1060	75%	2.24	2.19	2.20	2.18	2.23	2.21
1272	90%	2.55	2.51	2.49	2.49	2.52	2.51
1343	95%	2.70	2.62	2.64	2.63	2.65	2.65
1413	100%	2.98	3.00	2.92	2.94	2.92	2.95

FIG. 16.8 DIFFERENCE OF WATER LEVEL BETWEEN HIGH AND LOW TIDE IN PHU AN

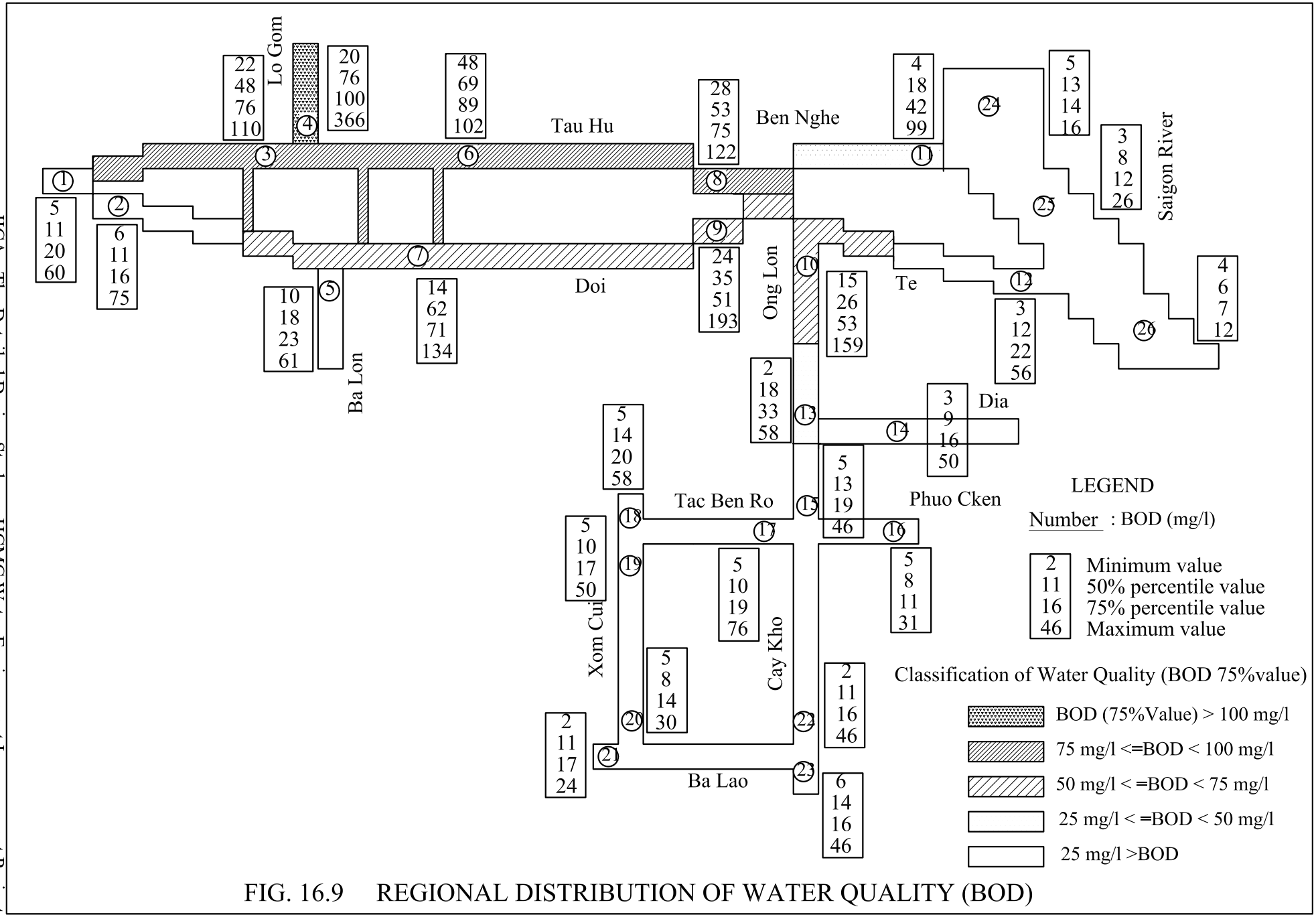


FIG. 16.9 REGIONAL DISTRIBUTION OF WATER QUALITY (BOD)

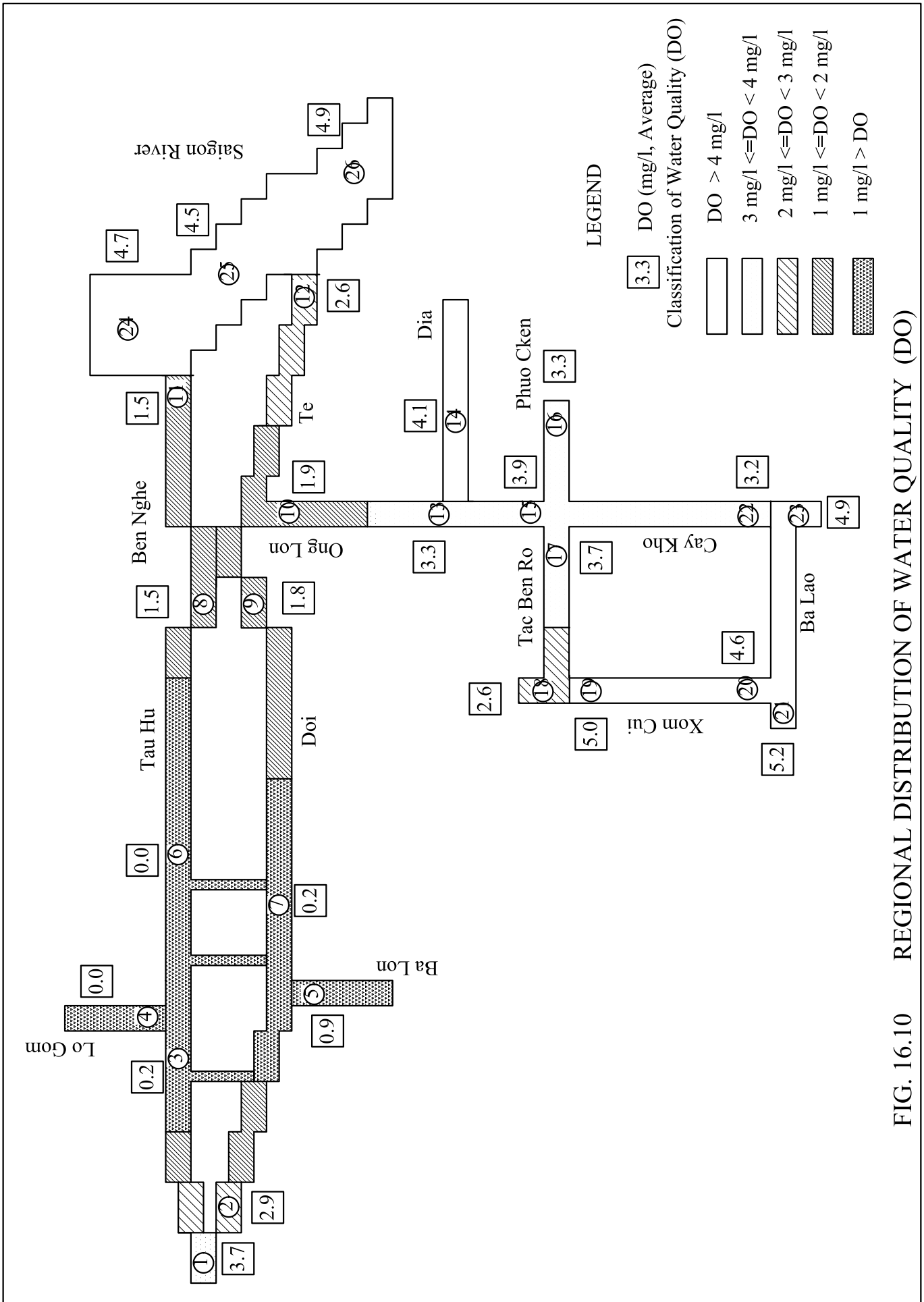


FIG. 16.10 REGIONAL DISTRIBUTION OF WATER QUALITY (DO)

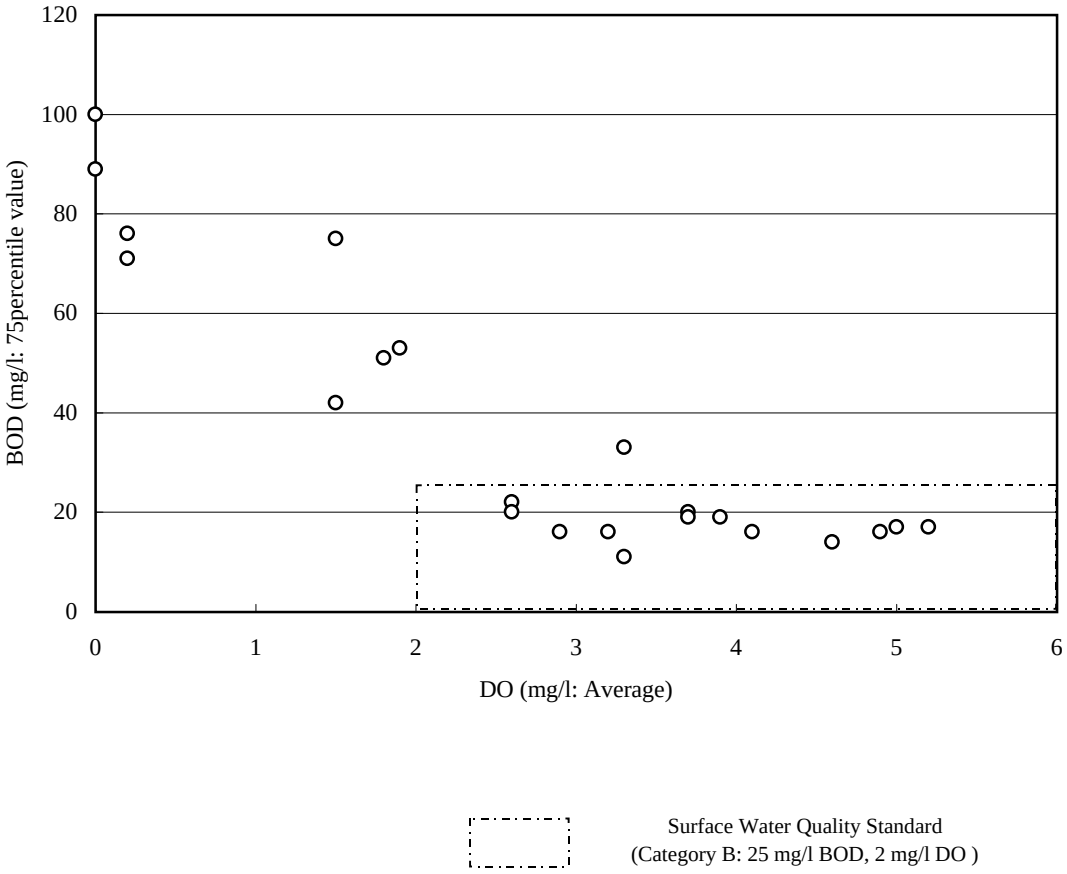


FIG. 16.11 RELATIONSHIP BETWEEN DO AND BOD

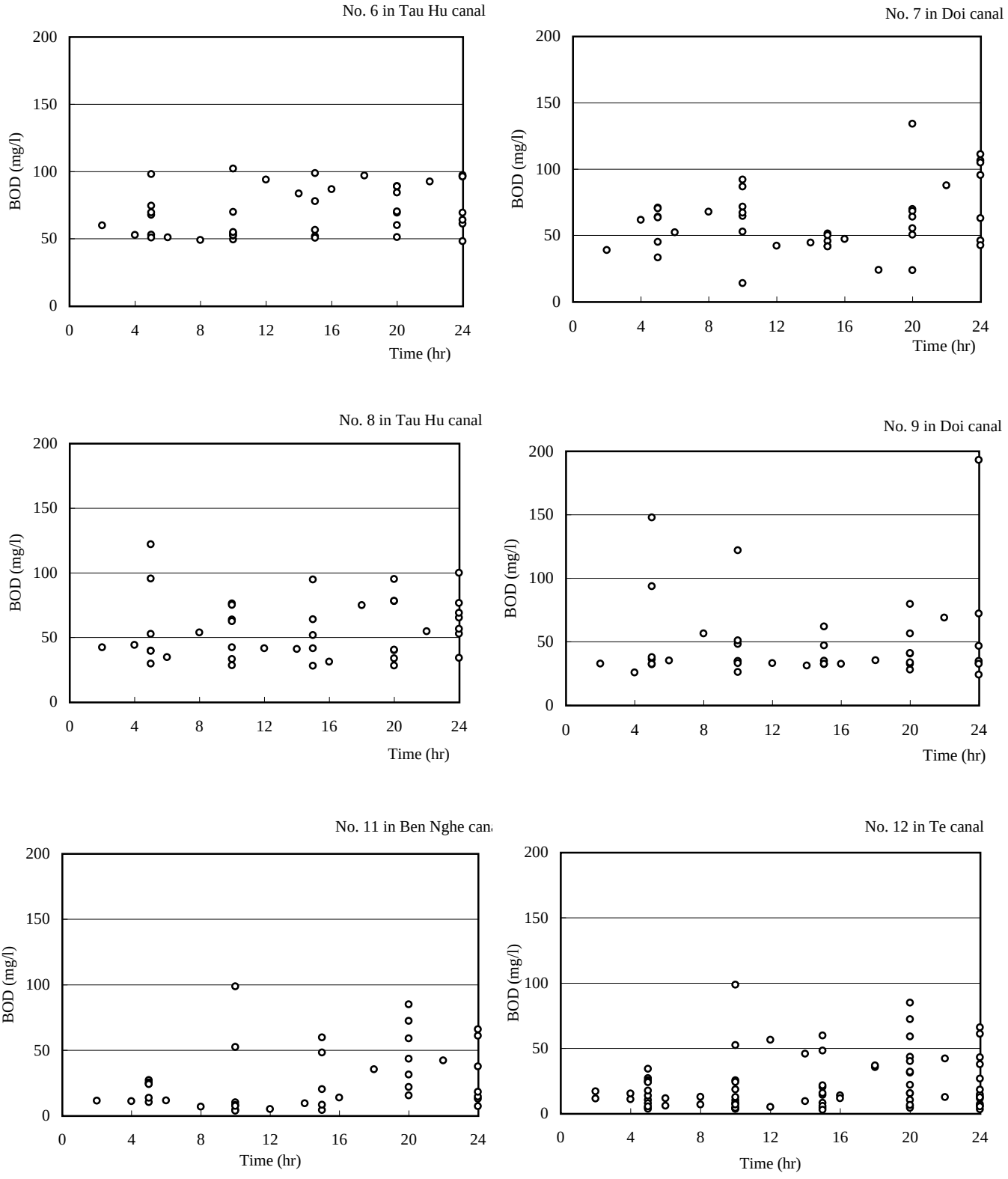


FIG. 16.12 VARIATION OF WATER QUALITY BY PEOPLE'S ACTIVITY

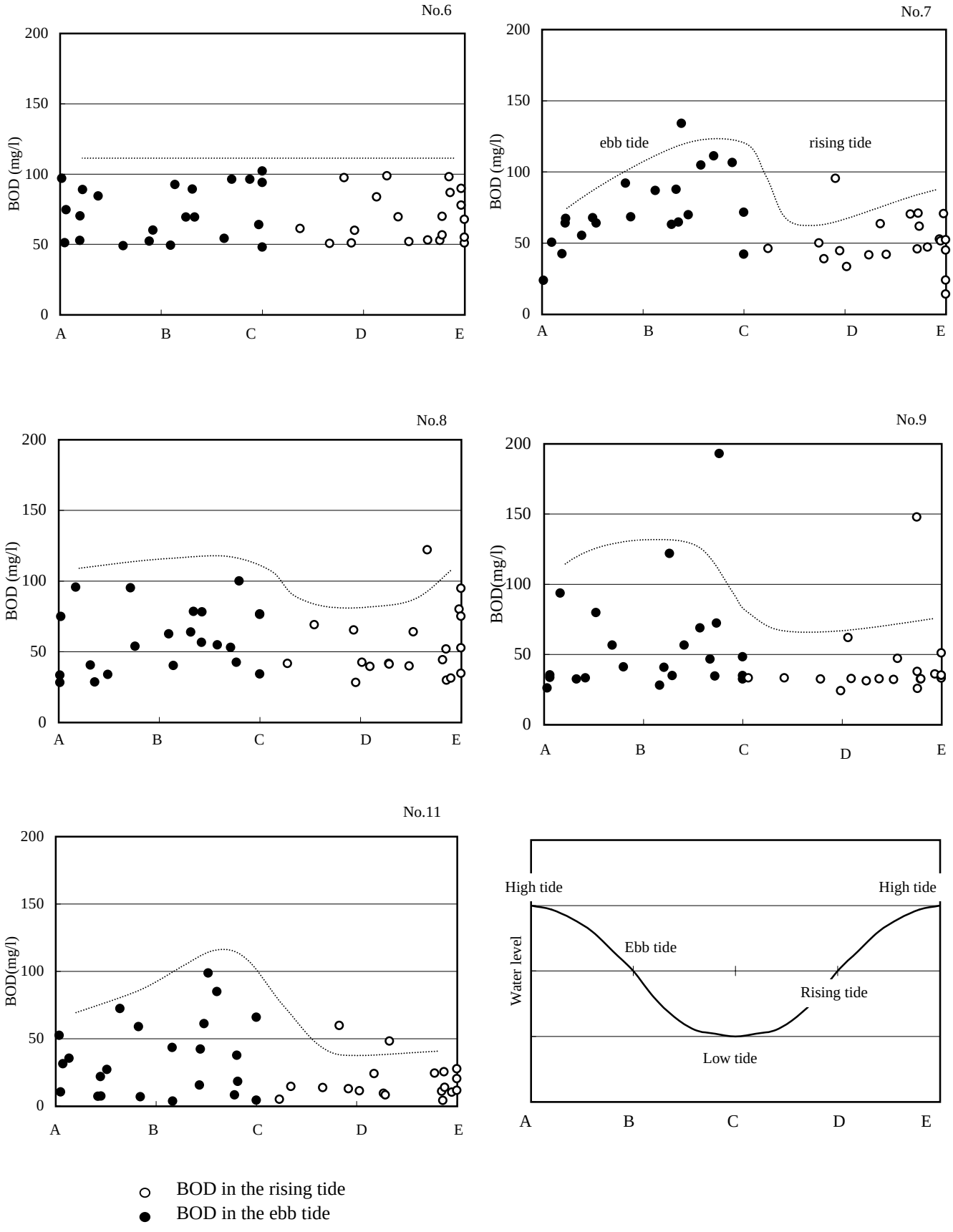


FIG. 16.13 VARIATION OF WATER QUALITY BY TIDAL EFFECT

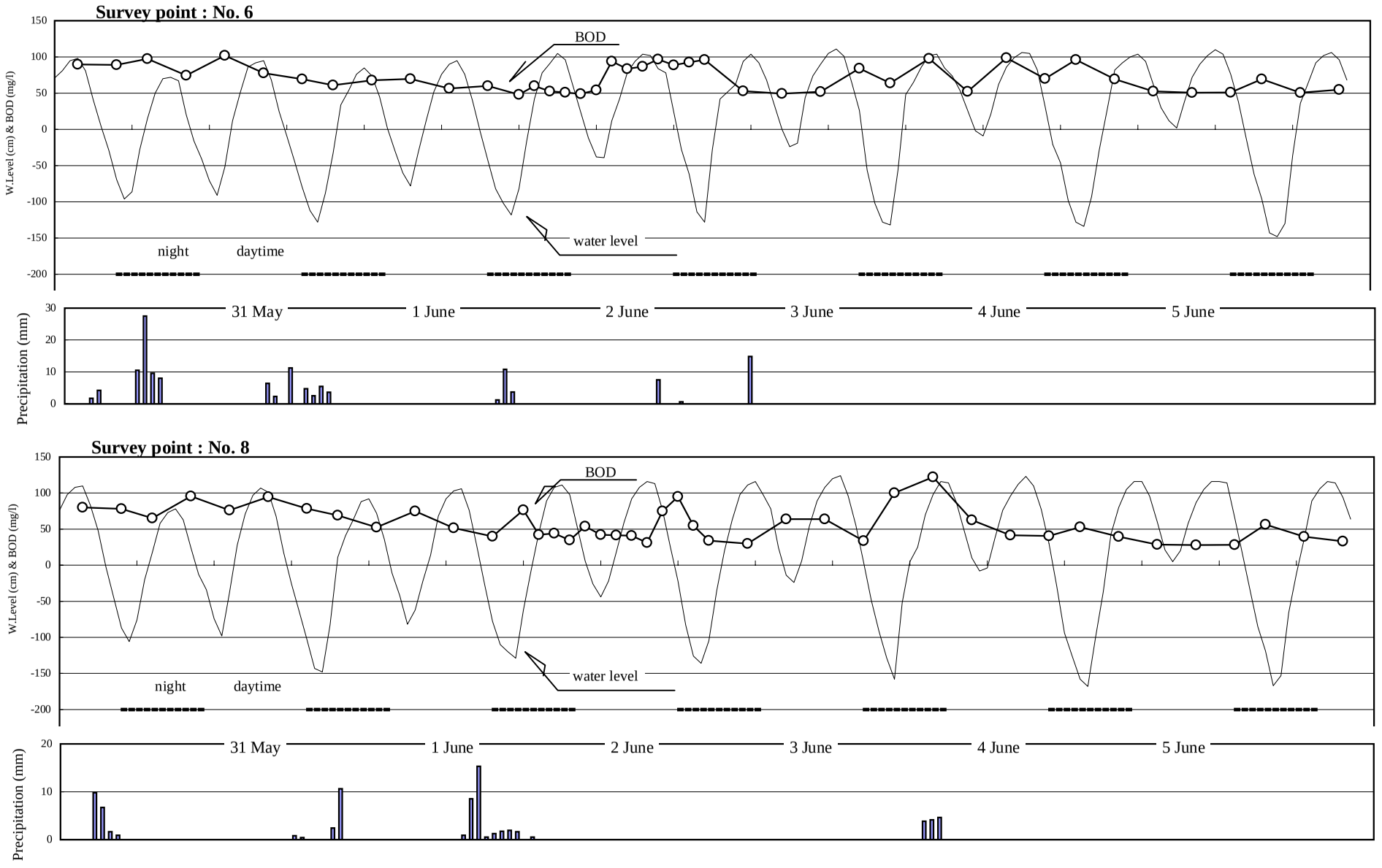


FIG. 16.14 RELATIONSHIP BETWEEN WATER QUALITY (BOD) AND RAINFALL

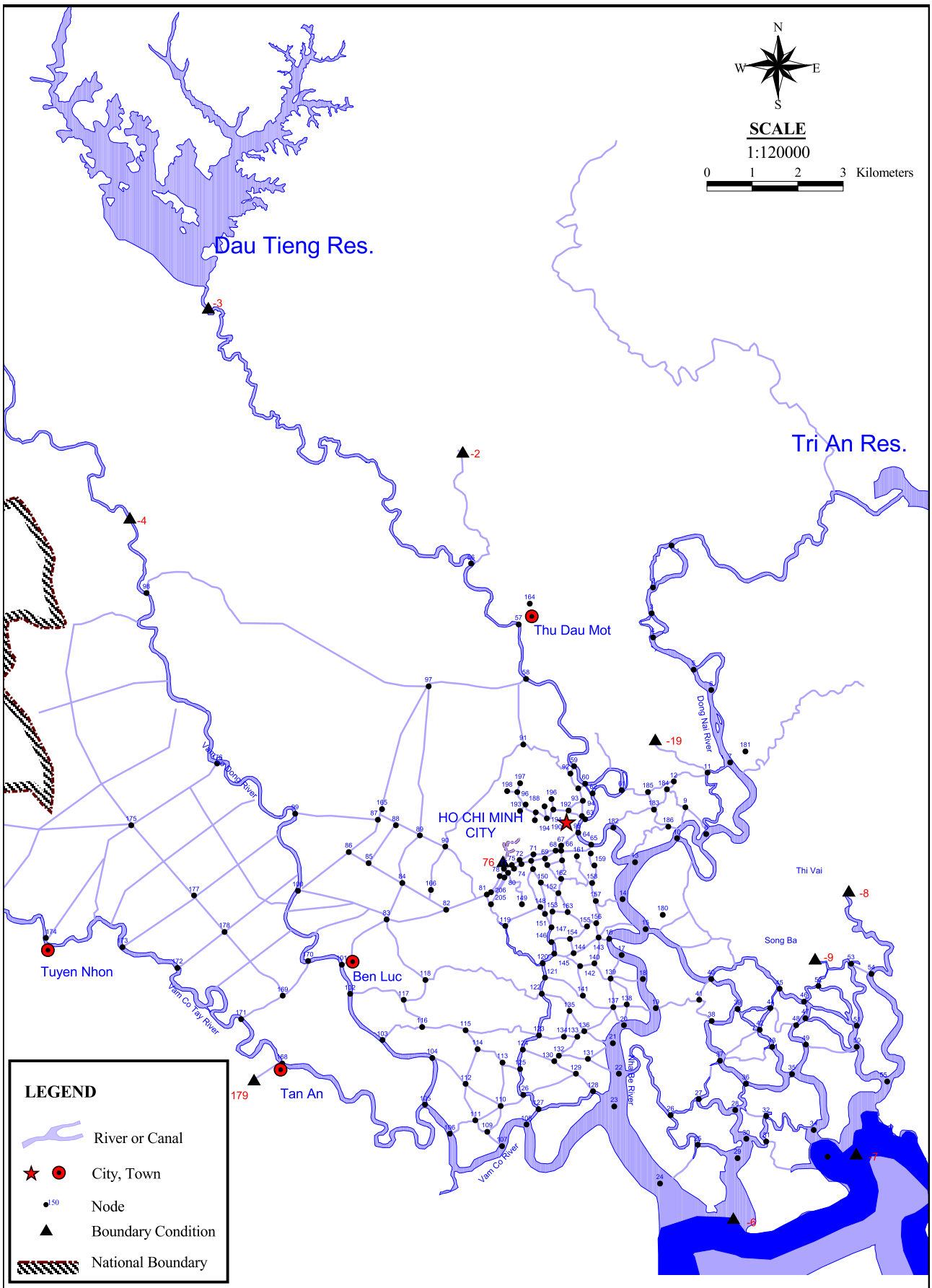


FIG. 16.15 HYDRAULIC SCHEMATIZATION AND POINTS OF BOUNDARY CONDITION

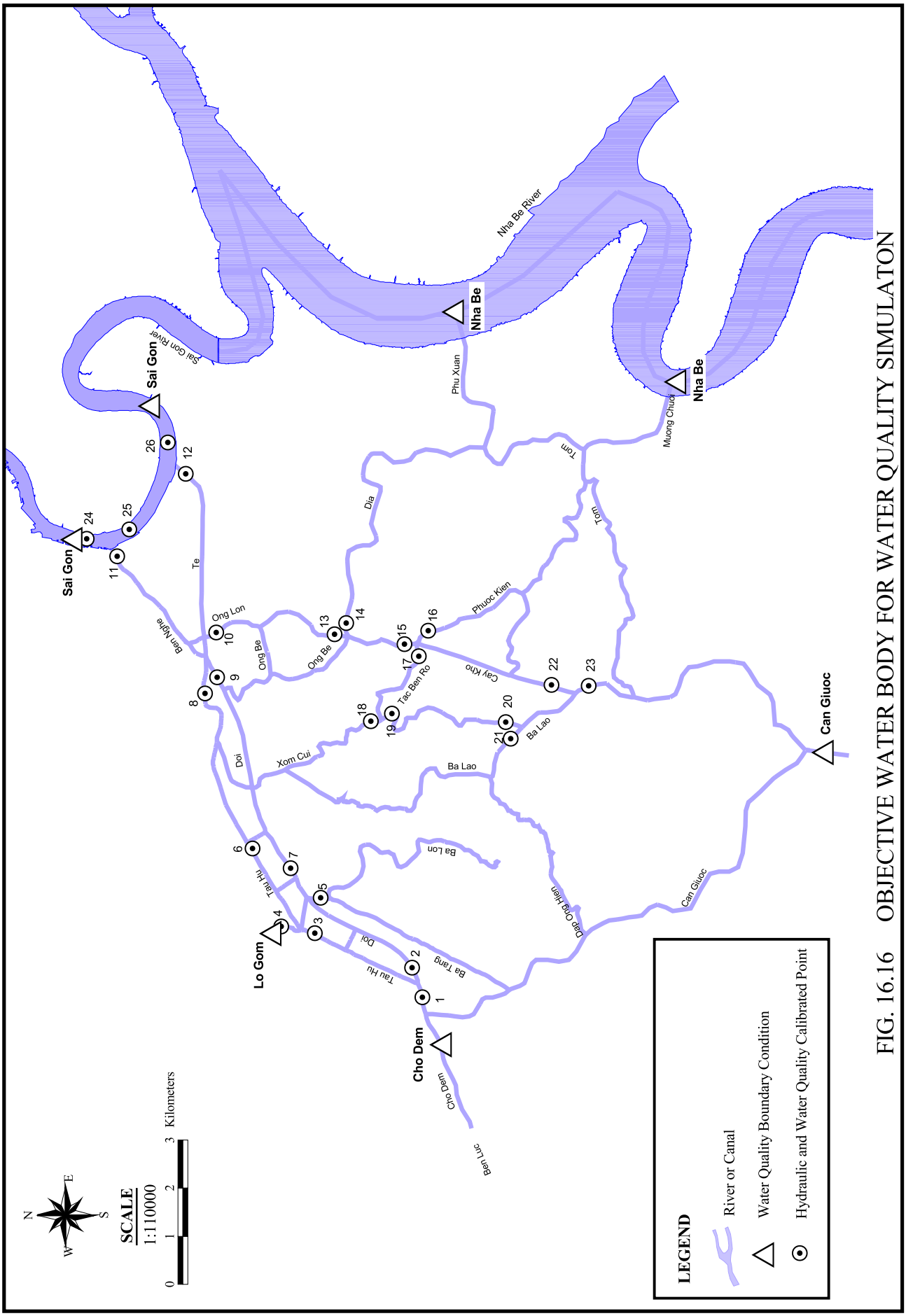


FIG. 16.16 OBJECTIVE WATER BODY FOR WATER QUALITY SIMULATON

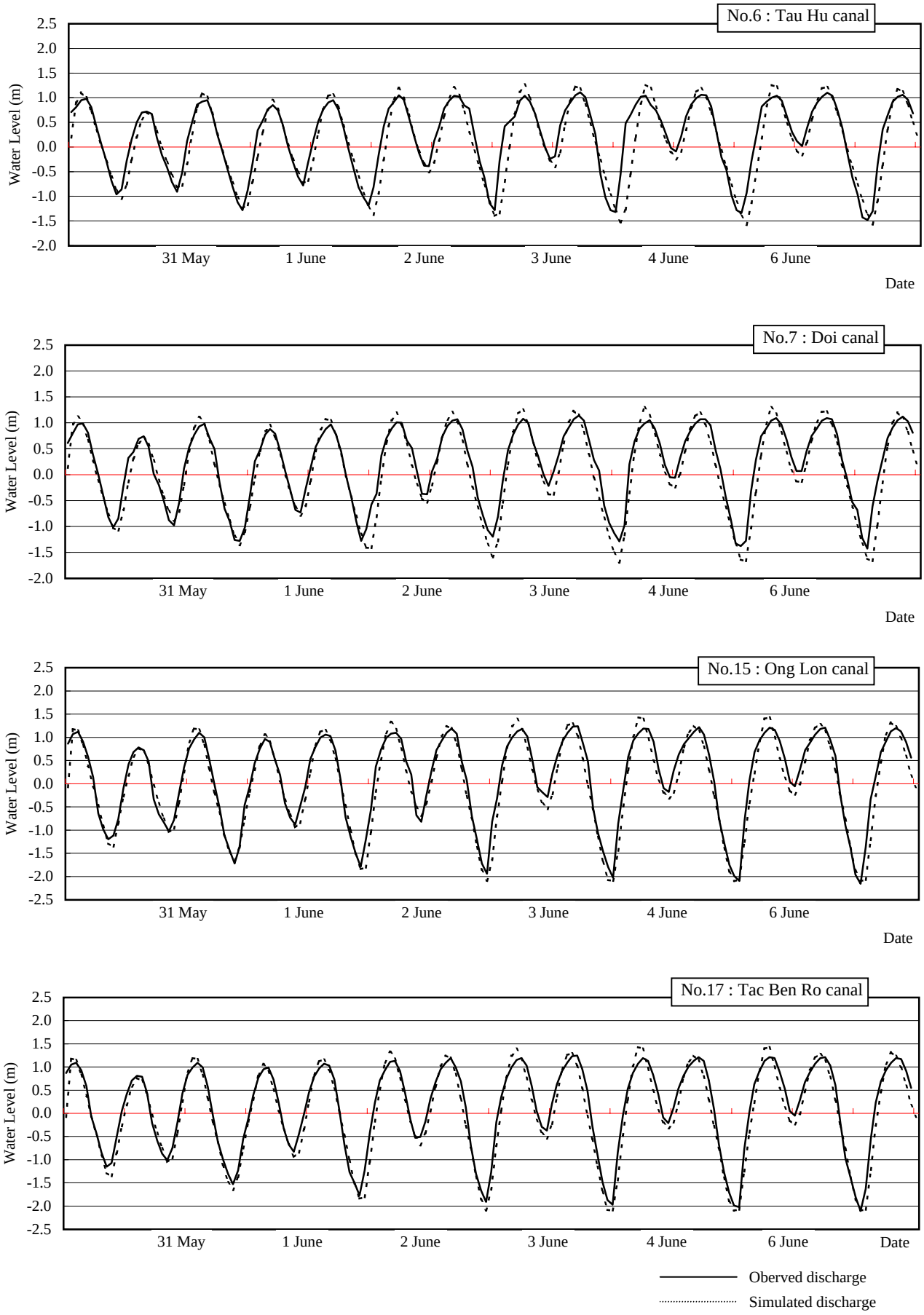


FIG. 16.17 RESULT OF PRESENT SIMULATION AND OBSERVED WATER LEVEL

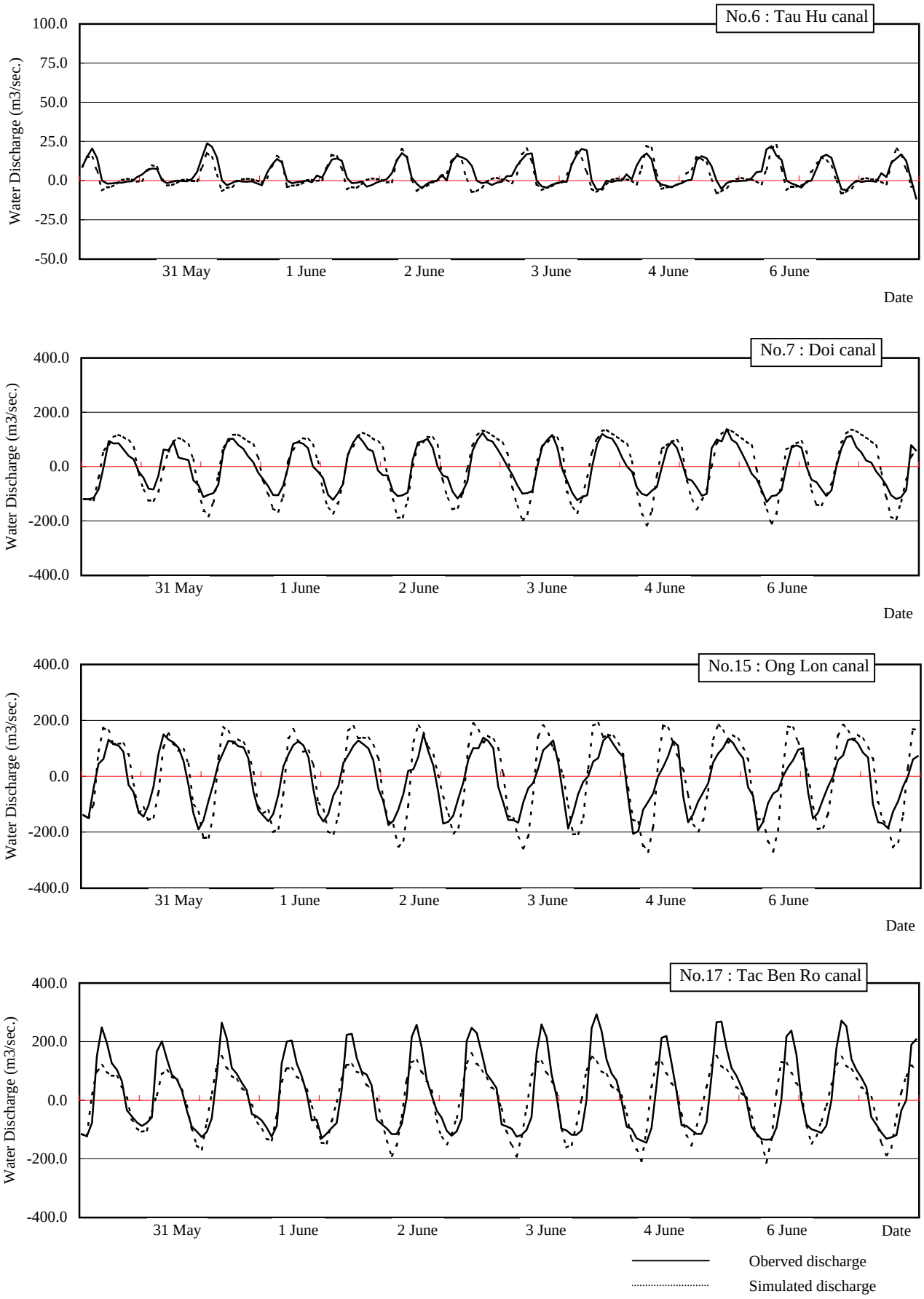


FIG. 16.18 RESULT OF PRESENT SIMULATION AND OBSERVED DISCHARGE

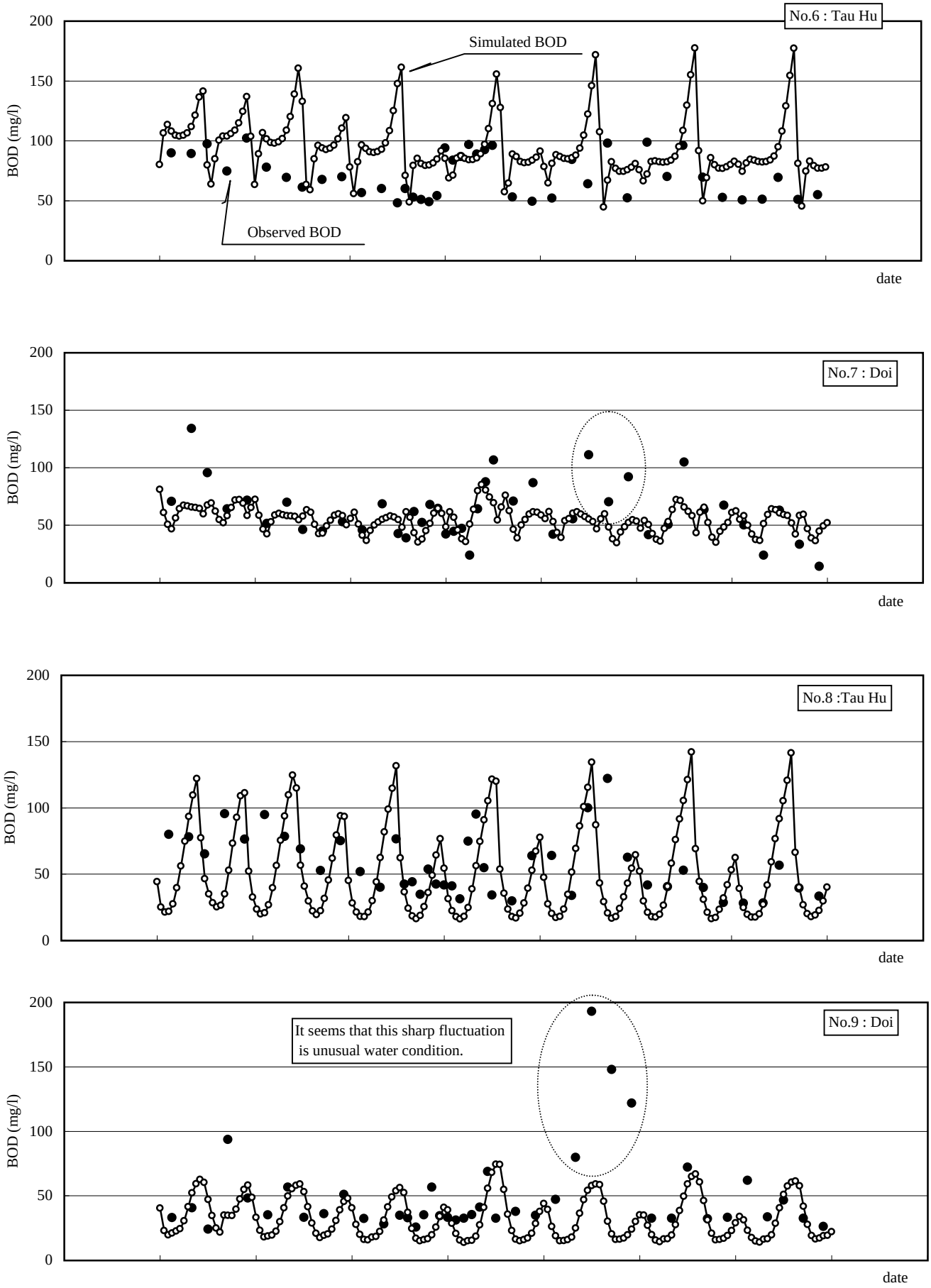


FIG. 16.19 (1/2) RESULT OF PRESENT SIMULATION AND OBSERVED WATER QUALITY (BOD)

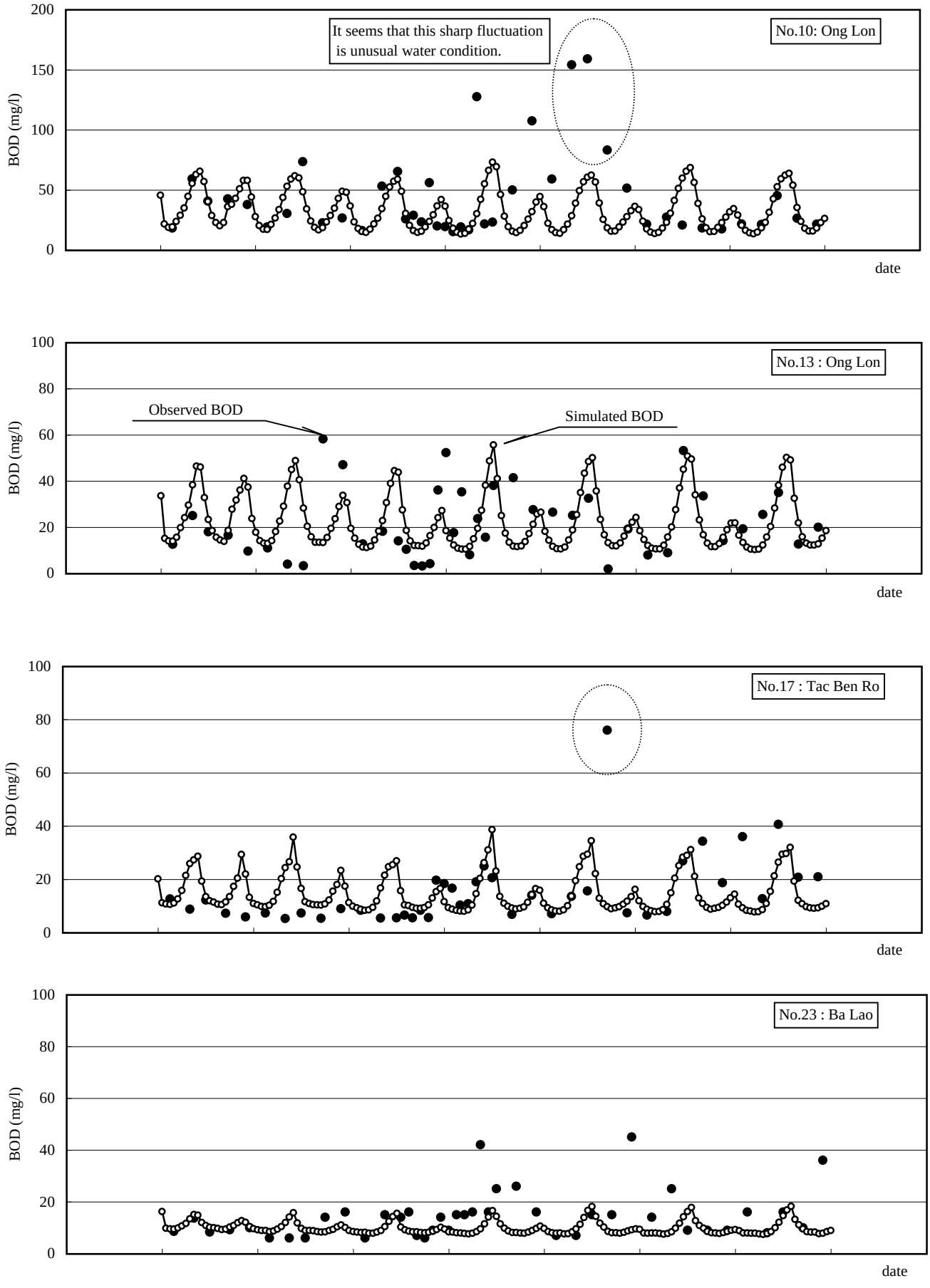


FIG. 16.19 (2/2) RESULT OF PRESENT SIMULATION AND OBSERVED WATER QUALITY (BOD)

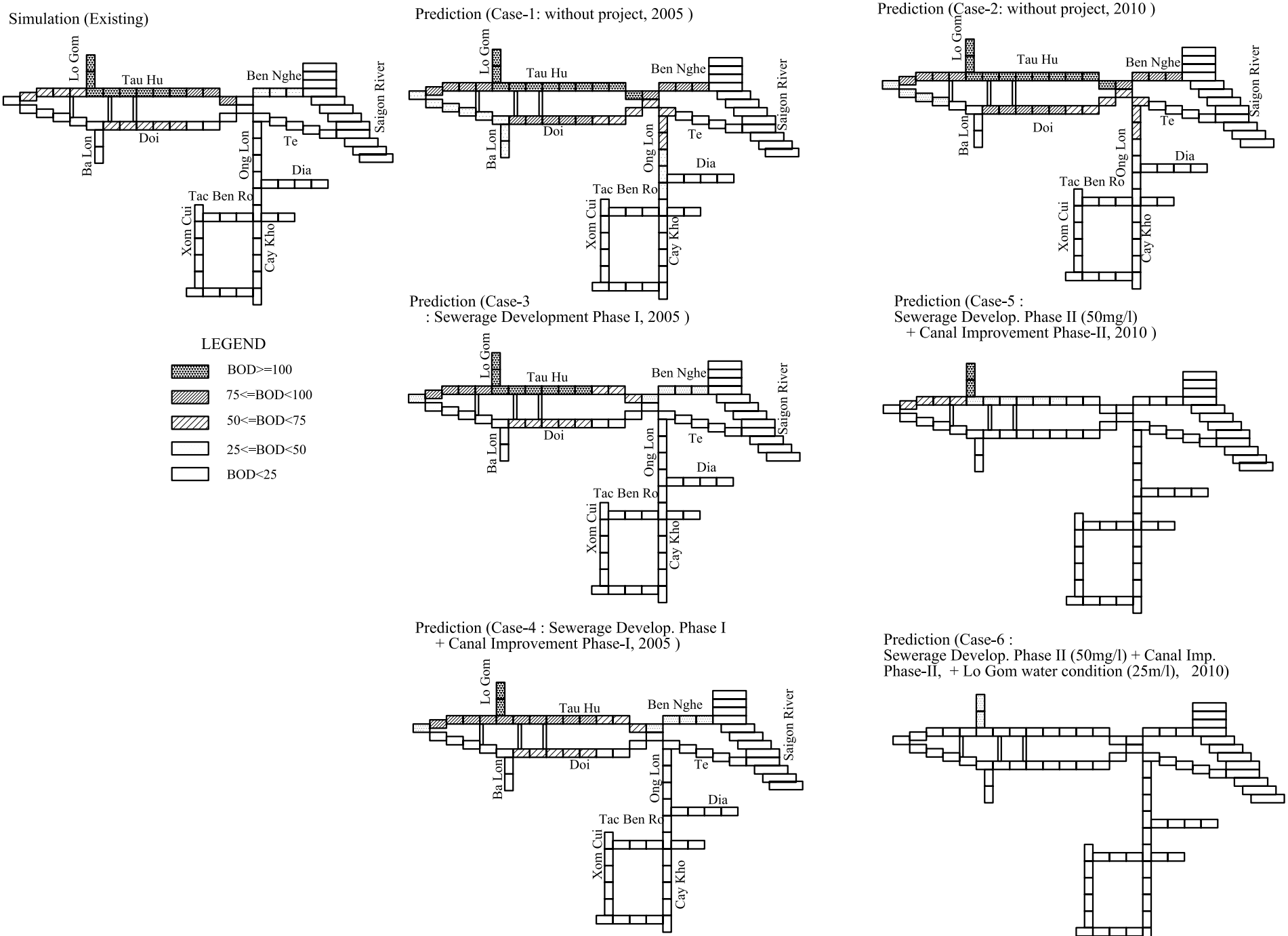


FIG. 16.20 RESULT OF SIMULATION AND PREDICTION

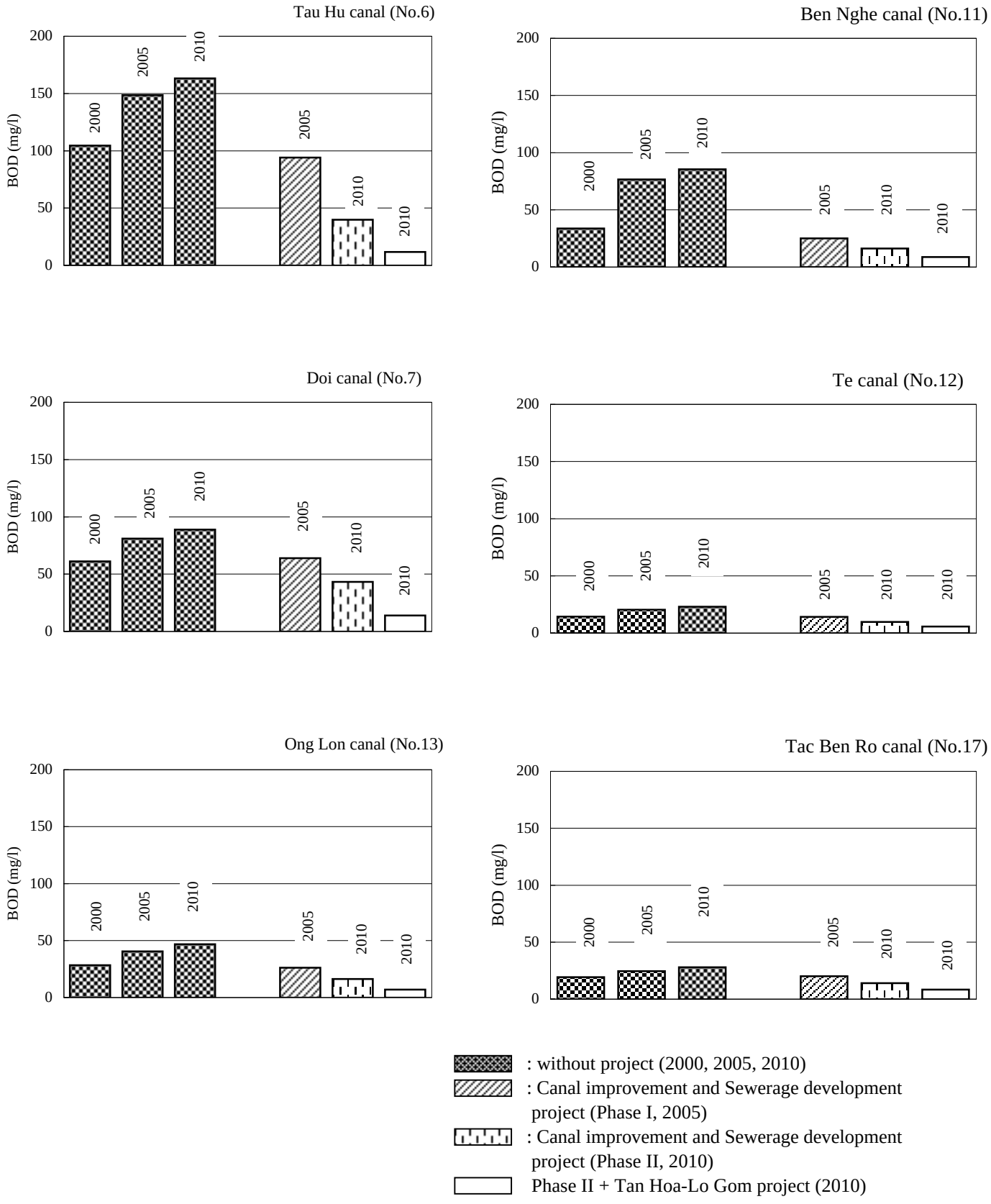


FIG. 16.21 EFFECTIVENESS OF WATER QUALITY IMPROVEMENT BY PROJECT

Chapter 17

ENVIRONMENTAL IMPACT ASSESSMENT

Chapter 17 ENVIRONMENTAL IMPACT ASSESSMENT

17.1 Introduction

The environmental assessment is carried out in four steps as below:

Step 1 Initial Environmental Examination (IEE) and preparation of Terms of Reference (TOR) for Environmental Impact Assessment Survey for the Priority Project, Tau Hu Ben Nghe Doi Te Project;

Step 2 Execution of Environmental Surveys and Environmental Impact Assessment (EIA) on Tau Hu Ben Nghe Doi Te Project;

Step 3 Revision of previous studies and preparation of TOR for Environmental Impact Assessment Survey for the Detailed Design Study on Ho Chi Minh City Water Environment Improvement Project (Tau Hu – Ben Nghe)

Step 4 Execution of Environmental Surveys and EIA on Ho Chi Minh City Water Environment Improvement Project (Tau Hu – Ben Nghe)

17.2 Environmental Legislation and Policies

17.2.1 Requirements for Environmental Impact Assessment

Environmental concerns and developments of environmental legislation and policies in Vietnam began in the early 1990s. The National Assembly of the Socialist Republic of Vietnam, at its 4th session of the IX Legislature, passed the Environmental Protection Law (EPL) on 27 December 1993. Subsequently the decree No. 175-CP was issued on the 18th October 1994 to provide guidance for the implementation of the Law on Environmental Protection. This specifies the requirements of an EIA at different stages of the project development. For the feasibility study, EIA report have to conduct with an outline to include specific chapters on project description, background information, impacts (on water, air, soil, biological, transportation, health, others), mitigation and conclusion.

The EIA report for the Feasibility project "Study on the Urban Drainage and Sewerage System for Tau Hu - Ben Nghe, Doi - Te Catchment" is made based the following legal foundations:

- Government Decree 175/CP issued on October 18, 1994 by the Government, in guidance on implementation of Environmental Protection Law;
- Introduction for guidelines on setting up and appraising the report of EIA to direct foreign investment projects (No. 1420/QD-Mtg);
- Decision of MOSTE minister on Promulgation of the regulation and organization of Appraisal Council on EIA and issuing environmental license (No. 1806/QD-Mtg);
- Regulation and organization of Appraisal Council on EIA report and issuing environmental license (No. 1807/QD-Mtg);
- Institution on guidance for preparation and appraisal of environmental impact assessment report for investment projects (No. 1100/TT-Mtg) and, other related regulations and laws.
- Regulation of Foreign Investment Law in Vietnam stipulated on November 12, 1996 (modified from 1987, 1990, 1992 version);
- Decree No 12/CP issued on February 18, 1997 by the Government, promulgating detailed regulations on implementation of Foreign Investment Law in Vietnam;
- Environmental Protection Law dated December 27, 1993 by the Parliament of the

Socialist Republic of Vietnam;
- Decision No 490/1998/TT-BKHCNMT issued on April 29,1998 by Ministry of Science, Technology and Environment in guidance on making and appraisal of Environmental Impact Assessment report for investment projects;
- Regulation on carrying out the environmental impact assessment for the project;
- Regulation on the infrastructure execution for Ho Chi Minh city.

17.2.2 Approval Procedure for EIA

Approval of an EIA report is a requirement for obtaining the necessary permit to proceed with the proposed development or renovation activities. Violators of EIA requirements as stipulated in Article 50 of the Law shall be subjected to administrative or criminal prosecution depending on the nature and extent of the environmental consequence.

The approval of an EIA report shall constitute one of the bases for overseeing authorities to approve a project or authorize its implementation. In December 1994, the MOSTE issued a decision to establish evaluation councils for EIA and environmental licensing. At the national level, the evaluation council is an advisory body to MOSTE, while at the local level the evaluation council advises the chair of the People Committee of provinces or cities, which assists in considering scientific and technical issues related to environmental protection identified in the EPL.

According to the MOSTE's Circular No. 490/1988/TT-BKHCNMT dated 29 April 1988, submission of an EIA report for approval to the state management agency for environmental protection is required. The circular specifies varying details of EIA report at three different stages namely during the request for investment permit, during the detailed design and construction, and prior to the project start up.
During the feasibility study of this project, it is required to submit the project documents, which contain a section or chapter, which presents brief potential environmental impacts from the project. The document must be submitted to the state management agency in charge of environmental protection for consideration, with onward submission to MOSTE for review and formal approval.
Upon receiving the project EIA, MOSTE shall seek the opinion from Ho Chi Minh City's DOSTE for consideration and grant decision on approval or shall seek further environmental mitigation measures within 60 days.

17.2.3 EIA Requirement during Detailed Design

The following contents should be included in the EIA Report for Detailed Design:
(1) Background

(2) Project Description
- Name of Project
- Name of Project Proponent
- Objectives of the Project
- Socio-economic Benefits of the Project
- Project Schedule
- Project Cost

(3) Existing Environments in the Project Vicinity

(4) Socio-economic Description
- Existing Project Vicinity
- Projection

(5) Impacts of the Projection Implementation on Resources and Environment
- Description of Following Impact Boundary, Characteristics and Magnitude in Comparison with the "No Project" Scenario

 Air
 Water
 Noise
 Soil
 Biological
 Solid Waste
 Historic Site
 Infrastructure
 Transportation
 Health
 Others

- Impact Evaluation of Project Option Alternative
- Mitigation Measures
- Overall Evaluation (Impact Assessment)

(6) Proposal for the Selected Option
- Proposal for Options Based on Environmental Consideration
- Proposal Based on the Economic and Mitigation Measures

17.2.4 Environmental Standards and Regulations

MOSTE has issued various environmental standards. MOSTE also allows a project proponent to propose equivalent standards from other countries for MOSTES's approval and for use where local and national standards are not available, inadequate, not regulated, not applicable, and finally not enforceable.

For carrying out this project, the existing provincial and national policy and requirement on wastewater collection, treatment and safe disposal of effluent have been considered. The appropriateness of the following set of Vietnamese standards has been evaluated and an affordable level of treatment is being proposed for approval by Ho Chi Minh City DOSTE and MOSTE to maximize the health benefit to the people.

17.3 EIA Results for Tau Hu Ben Nghe Doi Te Project in F/S Stage

17.3.1 Abstract

EIA was carried out from August – September 1999. The EIA report for "Study on the Urban Drainage and Sewerage System for Tau Hu - Ben Nghe, Doi - Te Catchment" has been made by Center for Environmental Technology and Management - CENTEMA, Van Lang University, Ho Chi Minh city with the participation of an expert group of high experience in establishing EIA report with specialization in: air pollution monitoring, wastewater pollution, noise, vibration, hazardous waste, environmental ecosystem, environmental economy, and the report is approved by MOSTE.

17.3.2 Significant Environmental Impact and Mitigation Measures

The proposed project will result in improvement of living environment, public health benefits and abatement of pollution to rivers and groundwater. Improper planning and engineering design and the use of inappropriate construction techniques/methods and equipments can be counterproductive and lead to serious negative short term and long term impacts. Potential and significant environmental impacts, both positive and negative are identified and assesses for

a) the pre-construction stage,
b) the construction stage, and
c) operation stage.

Table 17.1 shows the impact matrix for significant impacts and Table 17.2 elaborates Mitigation Measures.

17.4 EIA for the Detailed Design Study on Ho Chi Minh City Water Environment Improvement Project (Tau Hu– Ben Nghe)

17.4.1 Focus Points

In order to deepen the previous EIA study, the EIA for the detailed study will focus the following points:

- survey on a newly proposed wastewater treatment plant;
- survey on dredging activities for canals and dredged sludge dumping sites; and
- survey on traffic condition of construction sites during the construction phase.

17.4.2 Terms of Reference for EIA for the Detailed Design Study (Draft)

(1) Introduction

The Terms of Reference shall be applied to the Environmental Impact Assessment (EIA) for the Detailed Design Study on Ho Chi Minh City Water Environment Improvement Project (Tau Hu – Ben Nghe)

(2) Background

i) Objectives of the Study

An environmental impact assessment survey shall be carried out in accordance with legal requirements of the Socialist Republic of Vietnam and Ho Chi Minh City. The objectives of the survey are:

i) To identify project activities, particularly those which may cause significant environmental impacts;
ii) To describe the status of environmental quality in the project area, particularly those features which may experience impact in the future;

iii) To predict and evaluate the significant environmental impacts whether negative or positive;
iv) To provide the mitigation measures for preventing, minimizing, and eliminating the environmental impacts; and
v) To recommend countermeasures for environmental management and monitoring.

ii) Project Area

The detailed design study of the phase I consists of:
- Tau Hu - Ben Nghe Canal improvement of 7.36 km: sediments at the bottom will be dredged to increase the conveyance capacity and embankment will be constructed to improve the city environment.
- Pump drainage improvement at Thanh Da: Pump drainage system at Thanh Da consists of construction of storage tank, installation of pump, installation of drainage pipe, and construction of concrete pile revetment.
- Pump drainage improvement of Ben Me Coc (I); Pump drainage system at Ben Me Coc (1) consists of storage tank, installation of pump, installation of drainage pipe, and construction of temporary earth dike.
- Pump drainage improvement at Ben Me Coc (II): Ben me Coc (II) drainage system consists of installation of drainage pipe and construction of temporary earth dike.
- Interceptor sewer (including main and secondary interceptor sewer and diversion chambers)
- Intermediate sewage pumping station
- Conveyance sewer
- Wastewater treatment plant (Including inflow pump, primary sedimentation basin, aeration tank, secondary sedimentation basin, disinfection tank, gravity thickener, dewatering, and composting plant)

(3) Survey Guidelines

The EIA survey shall be carried out on the guidelines as shown the Section 2.2.

(4) Scope of Work

The survey include all works such as sampling, analysis of data, preparation of the EIA report and acquisition of the approval for EIA Report from the Appraisal Council of EIA. The format and contents of the EIA report shall follow the contents of EIA report which were defined by MOSTE, as also mentioned in Survey Guidelines.

(5) Specifications

i) Data Collection
Information and data are required to be obtained from primary and secondary sources. This data is to be used for identification of environmental impact and assessment. Secondary data is obtained from relevant institutions. Such data could also be obtained from previous relevant studies and investment study. Primary data such as those of physical nature, concerning biological ecosystems, nature resources and quality of life parameters are obtained from field observation and measurement activities.

a) Physical Environment
   - Meteorology
   - Hydrology and Water Quality Survey
   - Air Quality Survey
   - Noise and Vibration Survey
   - Geology and Soil

b) Biological Resources and Ecosystem
   - Land Ecology
   - Aquatic Ecology

c) Natural Resources
   - Land Use

d) Quality of life
   - Demographic and Socioeconomic conditions
   - Public Utilities
   - Public Health
   - Aesthetics
   - Cultural and Historical Values

ii) Water Quality Survey

a) Surface Water Quality

Sampling points:

7 locations (including 4 locations (SW1, SW2, SW3 and SW4) around the construction area of wastewater treatment plant as shown in Fig. 17.1 and 3 locations for dredged sludge dumping sites (not determined).

Total samples:

At each location, for two depth and for both high tide and low tide (7 x 2 x 2 = 28).

Parameters:

pH, alkalinity, acidity, TDS, turbidity, SS, DO, BOD_5, COD, $N\text{-}NH_3$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, N-Org, $P\text{-}PO_4^{3-}$, Phenol, Oil, Cr^{3+}, Cd, Pb, As, Hg, Fecal Coliform, Total Coliform, Pesticides Cl, and Pesticides P.

b) Groundwater Quality

Sampling points:

3 locations for dredged sludge dumping sites (not determined).

Total samples:

3 samples

Parameters:

pH, TDS, turbidity, $N\text{-}NH_3$, $N\text{-}NO_2$, $N\text{-}NO_3$, $P\text{-}PO_4^{3-}$, Fe, Cr^{3+}, Cd, Pb, As, Hg, Ecoliform, Fecal Coliform.

iii) Air Quality, Noise and Vibration Survey

(a) Sampling

Sampling points:

33 locations as shown in Fig. 17.2 and 3 locations for dredged sludge dumping sites (not determined).

Sampling methods:

Sampling time is divided into the following classes:

- Rush hours (from 6:30 to 7:30 and from 17:30 to 18:30),
- Official hours (from 8:00 a.m. to 12:00 a.m. and from 13:30 to 17:30)
- Resting time (from 22:00 to 6.00)

Sampling is carried out three times (each one for rush hours, official hours, and resting time) per day except for dredged sludge dumping sites (one time per day). Sampling days are two (one weekday and one holiday per location).

(b) Parameters:

- micro climate (^{o}C, humidity, wind), noise and vibration, dust, $NO_{x,}$ SO_2, CH_4, NH_3, CO_2, CO, H_2S, Pb, microorganism for 14 points (nearby canal areas and sludge dumping sites).
- micro climate (^{o}C, humidity, wind), noise and vibration, dust, $NO_{x,}$ SO_2, CO_2, CO, Pb, microorganism for 21 points (nearby canal areas and sludge dumping sites).

iv) Traffic Density Survey

a) Road Traffic

Survey points: 22

Survey method:

Survey time is divided into the following classes:

- Rush hours (from 6:30 to 7:30 and from 17:30 to 18:30),
- Official hours (from 8:00 a.m. to 12:00 a.m. and from 13:30 to 17:30)
- Resting time (from 22:00 to 6.00)

Survey is carried out three times (each one for rush hours, official hours, and resting time) per day. Survey days are two (one weekday and one holiday).

Types:
bicycle, handicart, trice bicycle, motorbike, car (including taxi), bus (including tourist car, less than 25 or more than 25 seats), truck (less than 5 tons, from 5 tons to 10 tons, more than 5 tons)

b) Canal Traffic
Survey point: 5 locations
Survey method:
Survey time is divided into the following classes:

- Rush hours (from 6:30 to 7:30 and from 17:30 to 18:30),
- Official hours (from 8:00 a.m. to 12:00 a.m. and from 13:30 to 17:30)
- Resting time (from 22:00 to 6.00)

Survey is carried out three times (each one for rush hours, official hours, and resting time) per day.

Types: junk, motor-boat, small boat (less than 5 tons), large boat (larger than 0.5 tons), boats using as houses along the canal

v) Sediments and Soils Survey

a) Sediment Quality
Sampling points:
12 points (including 5 points (DS1, DS2, DS3, DS4, and DS5) for canals, 4 points (DS6, DS7, DS8, and DS9) for wastewater treatment plant as shown in Fig. 17.1, and 3 points for dredged sludge dumping sites (not determined)
Total Samples: 12 samples

Parameters:
Organic matter, total P, total nitrogen, heavy metals (Hg, Cd, As, Pb, Cr), pesticides Cl and pesticides P, Oil, phenol, sand, fecal coliform, total coliform

b) Soil Quality
Sampling Point:
2 samples near wastewater treatment plant site, 2 samples at each dredged sludge dumping sites (3 x 2). Total sample number is 8.

Parameters:
Organic matter, total P, total nitrogen, heavy metals (Hg, Cd, As, Pb, Cr), pesticides Cl and pesticides P, Oil, phenol, sand, fecal coliform, total coliform

(6) Identification of Impact

Environmental impacts including those positive and negative are to be identified based on collected data utilizing analytical method. The impacts are to be identified for pre-construction, construction and operation stages. In each stage impact is to be identified based on following factors:

- Number of people subject to impact
- Extent of the impact
- Impact duration
- Number of environmental component, which are simulation, affected by the impact
- Cumulative aspects of the impact
- Irreversibility of the impact

(7) Assessment and Evaluation of Impact

The impact assessment on the above environmental parameters resulting from the project should be discussed based on suitable techniques. Quantitative methods for impact assessment should be used wherever applicable to accurately portray the level of impact.

(8) Formulation of Environmental Management Plan

An Environmental Management Plan (EMP) should be drawn up to control and curb adverse environmental impact that is determined by the above. The environmental management plan could be of suggested control system as needed as well as a monitoring program. The EMP consists of basic guidance in environmental management based on the observation results. The EMP should be prepared in detail and as complete as possible, covering:

- type of activities that particularly increase the significance of the impact
- type of impacts that should be monitored and managed
- approach of arrangement, control and management for minimization of negative impact and maximization of positive impact.
- type of environmental component that should be monitored.

17.4.3 Reporting

(1) Submission of Reports

The consultant shall submit following reports to the study Team in the English and Vietnamese (language) according to the following schedule.

1) Inception Report
2) Draft Final Report
3) Final Report

(2) Contents of Report

The format of EIA report shall be based on the content as shown in Section 2.3.

17.4.4 Time of Completion of Work

Expected Survey duration	Nov - Dec 2000
Approval expected	Jan 2000

17.4.5 Equipment, Materials and Labor

All the necessary equipment, materials and labor for all the above mentioned work shall be provided by the consultant.

17.5 Monitoring Program (draft)

17.5.1 Monitoring Program during the Construction Phase (draft)

Ho Chi Minh City has a surface water quality and air quality monitoring systems. With using above monitoring systems, the project should have an original monitoring program in the construction phase to protect and preserve the environment. During the EIA study, the monitoring program will be proposed. Here, a draft for the monitoring program is shown below.

Monitoring shall be carried out under the supervision of the Department of Science, Technology and Environment of Ho Chi Minh City.

(1) Water Quality Monitoring

i) Saigon River (at the junction with Ben Nghe Canal)

The contamination level from the Ben Nghe Canal during the construction phase of the Tau Hu – Ben Nghe Improvement will be monitored.

(a) Periodical Monitoring

Measurement condition is as follows:
- First Phase: 2 years, Second Phase: 2 years
- 4 times per year
- 2 sampling depth
- sampling at low and high tides
- parameters
  pH, Turbidity, Alkalinity, Acidity, TDS, SS, DO, COD, BOD_5, Cl^-, $N\text{-}NH_3$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, N-Org, $P\text{-}PO_4^{3-}$, Phenols, Oil, Cr^{3+}, Pb, Cd, As, Hg, Fecal Coliform, Total Coliform, Pesticide Cl, Pesticide P

ii) Tau Hu – Ben Nghe Canal

(a) Daily Monitoring
- Observation

- Turbidity measurement at two sides of construction activity

(b) Periodical Monitoring

Measurement condition is as follows:
- 6 cross sections of Tau Hu – Ben Nghe Canal
- First Phase: 2 years, Second Phase: 2 years
- 4 times per year
- 2 sampling depth
- sampling at low and high tides
- parameters
  pH, Turbidity, Alkalinity, Acidity, TDS, SS, DO, COD, BOD_5, Cl^-, $N\text{-}NH_3$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, N-Org, $P\text{-}PO_4^{3-}$

iii) Wastewater Treatment Plant

Surface water monitoring will be carried out in order to protect the surface water quality of river/canal from construction activities during construction phase.

(a) Periodical Monitoring

Measurement condition is as follows:
- 3 cross sections
- First Phase: 4 years, Second Phase: 4 years
- 6 times per year
- 2 sampling depth
- sampling at low and high tides
- parameters
  pH, Turbidity, Alkalinity, Acidity, TDS, SS, DO, COD, BOD_5, Cl^-, $N\text{-}NH_3$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, N-Org, $P\text{-}PO_4^{3-}$

iv) Dredged Sludge Dumping Sit

(a) Periodical Monitoring

Measurement condition is as follows:
- 1 dumping site
- 1 location per each dumping site
- First Phase: 2 years, Second Phase: 2 years
- 6 times per year
- sampling at low and high tides
- parameters
  pH, Turbidity, Alkalinity, Acidity, TDS, SS, DO, COD, BOD_5, Cl^-, $N\text{-}NH_3$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, N-Org, $P\text{-}PO_4^{3-}$, Phenols, Oil, Cr^{3+}, Pb, Cd, As, Hg, Fecal Coliform, Total Coliform, Pesticide Cl, Pesticide P

(2) Air Quality, Noise and Vibration Monitoring

i) Interceptor, Conveyance, Conbined Sewer, Storm Water Drainage

(a) Daily Monitoring for Each Construction Sites in Inner City
- Observation
- Traffic Control

(b) Periodic Monitoring
- Monitoring is proposed at 6 locations
- 6 times per year (First Phase: 3.5 years, Second Phase: 4 years).
- Parameters: noise, vibration, dust, NO_x, SO_x, and CO.
- Sampling/measuring at three time per day

ii) Pumping Stations and Wastewater Treatment Sites

- Thanh Da Pumping Station (First Phase: 1.5 years)
- Ben Me Coc (1) (First Phase: 1.5 years, Second Phase: 1 year)
- Ben Me Coc (2) (Second Phase: 1 year)
- Wastewater Pumping Station (First Phase: 0.5 year)
- Wastewater Treatment Plant (First Phase 4 years, Second Phase 4 years)

(a) Daily Monitoring only for Thanh Da Pumping Station
- Observation
- Traffic Control

(b) Periodical Monitoring
Monitoring is proposed at 2 locations for each pumping station or wastewater treatment plant.
Monitoring frequency is 4 time per year.
Parameters: noise, vibration, dust, NO_x, SO_x, and CO.
Sampling/measuring at three times per day

iii) Tau Hu – Ben Nghe Canal

(a) Daily Monitoring during construction
- Observation
- Traffic Control

(b) Periodical Monitoring
Monitoring is proposed at 5 locations. Monitoring frequency is 4 times per year.
Parameters: noise, vibration, dust, NO_x, SO_x, CO, NH_3, H_2S and CH_4.
Sampling/measuring at three times per day

iv) Dumping Sites

(a) Periodical Monitoring
Monitoring is proposed at a location. Monitoring frequency is 12 times per year.

Parameters: dust, NO_x, SO_x, NH_3, H_2S and CH_4.
Sampling/measuring at one time per day.

(3) Sediment Quality Monitoring

Monitoring is proposed at 1 location for a dumping site. Monitoring frequency is 1 time per year.
Parameters: organic matters, total P, total nitrogen, heavy metals (Cd, As, Pb, Cr, Hg), pesticides Cl and P, phenols, sand, fecal coliform, total coliform.

17.5.2 Monitoring Program during the Operation Phase

The following monitoring program is necessary:
- Water quality of the wastewater from the wastewater treatment plant;
- Water quality of river/canal around the wastewater treatment plant; and
- Water quality of Tau Hu – Ben Nghe Canal.

The details shall be determined during the EIA procedure.

17.6 Subjects in the Next Step of Detailed Design Study

- Planning the interview with residents on the water improvement project (20 to 30 samples)
- EIA
- Interview
- Environmental Management (including monitoring plan in construction and operation phase)

Table 17.1 Significant Impact Matrix

Project activity	Natural Environment							Social Environment			
	Aesthetic View	Surface water	Ground water	Air Environment	Soil Environment	Biological Resources & Ecosystem	Prevention of flood	Living Environment (Public health)	Infrastructure	Relocation	Employment opportunity
1 Pre Construction Stage											
Land procurement	-	-	-	-	-	CB	-	-	-	AA	-
2 Construction Stage											
2.1 Construction of Sewers and Rehabilitation of Existing Sewers											
Transportation of construction material	CB	CB	-	CB	-	-	-	CB	-	-	P
Excavation work	BB	CB	-	CB	-	-	CB	-	CB	-	P
Transportation and disposal of spoil	BB	BB	-	CB	BA	-	-	-	-	-	P
Transportation and disposal of sediment	BB	BB	-	CB	BA	-	-	-	-	-	P
2.2 Improvement of Tau Hu-Ben Nghe, Doi-Te Canals											
Dredging of sediment from THBN canal	CB	AB	-	CB	-	CB	P	CB	CB	-	P
Construction of THBNDT canals	CB	BB	-	CB	-	CB	P	-	P	-	P
Transportation and disposal of sediments	CB	BB	-	CB	BA	CB	-	CB	-	-	P
3 Operation Stage											
3.1 Operation of Sewerage System and Tau Hu - Ben Nghe Canal											
Disposal of sewer sediment	CB	CB	-	CB	CA	-	-	CB	-	-	P
Disposal of sediment dredging	CB	CB	-	CB	CA	-	-	CB	-	-	P
Wastewater discharge	-	CA	P	CA	P	P	P	P	-	-	-
3.2 Operation of Wastewater Treatment Plant											
Treated wastewater discharge	-	P	P	P	P	P	-	P	-	-	P
Disposal of solid waste from pumping stations	CB	CB	-	CB	BA	-	-	CB	-	-	P
Disposal of sludge from wastewater treatment plant	CB	CB	-	CB	BA	-	-	CB	-	-	P

Note P=> Positive Impact
AA => Serious Negative Long-term Impact
AB=> Serious Negative Short-term Impact
BA=> Moderate Negative Long-term Impact
BB=> Moderate Negative Short-term Impact
CA => Minor Negative Long-term Impact
CB=> Minor Negative Short-term Impact

Table 17.2 (1/2) Summary of Significant Environmental Impacts Mitigation/Compensation Measures

PROJECT ACTIVITY	IMPACT DESCRIPTION	CATEGORY	IMPACT	MITIGATION
1. Pre-Construction Stage (immediate impact)				
Land procurement for interceptor and WTP	- Domestic life - Culture - Activity of factory in project area	Social	Serious	- Ensure procurement - Compensation - Relocation program - Creation of new jobs
2. Construction Stage (immediate or short-term impacts)				
- Dredging and excavation works	- Water pollution by sediment - Drilling of spoil and filling construction material	Physical	Moderate	- Proper procedure for dredging - Temporary storage - Proper operation and maintenance of vehicles and equipment
- Transportation of sediment, spoil, fill material	- Air pollution by CO_2, NO_x, SO_2 from construction vehicles and equipment - Traffic			- Proper operation and maintenance of vehicles and equipment and use of EM product to avoid smell from sediment
- Disposal of sediment and spoil	- Air pollution by CO_2, NO_x, SO_2, H_2S, CH_4 from construction vehicles and sediment - Spoil and sediment pollution - Soil pollution			- Proper levelling program
- Construction activity	- Noise, vibration and air pollution - Strain on infrastructure due to labour influx			- Take proper construction procedure to avoid wash away of material - Provide waste disposal facilities for temporary shelters for labour

Table 17.2 (2/2) Summary of Significant Environmental Impacts Mitigation/Compensation Measures (Continued)

PROJECT ACTIVITY	IMPACT DESCRIPTION	CATEGORY	IMPACT	MITIGATION
3. Operation Stage (long-term impact)				
- Disposal of sewer sediment - Disposal of sludge - Operation of pumping station - Operation of WWTP	- Soil pollution by sediment - Soil pollution by solid waste from screen - Air pollution - Treated wastewater discharge - Excess combined waste and storm water discharge	Physical	Moderate	- Proper disposal (levelling) - Proper disposal (Landfilling) - Good ventilation - Dilution and flood out by tide regime - Proper diversion chamber for dilution

Note: Impacts are classified as Serious, Moderate and Monitor, of which only serious impact will endanger the Project implementation or its sustainability.

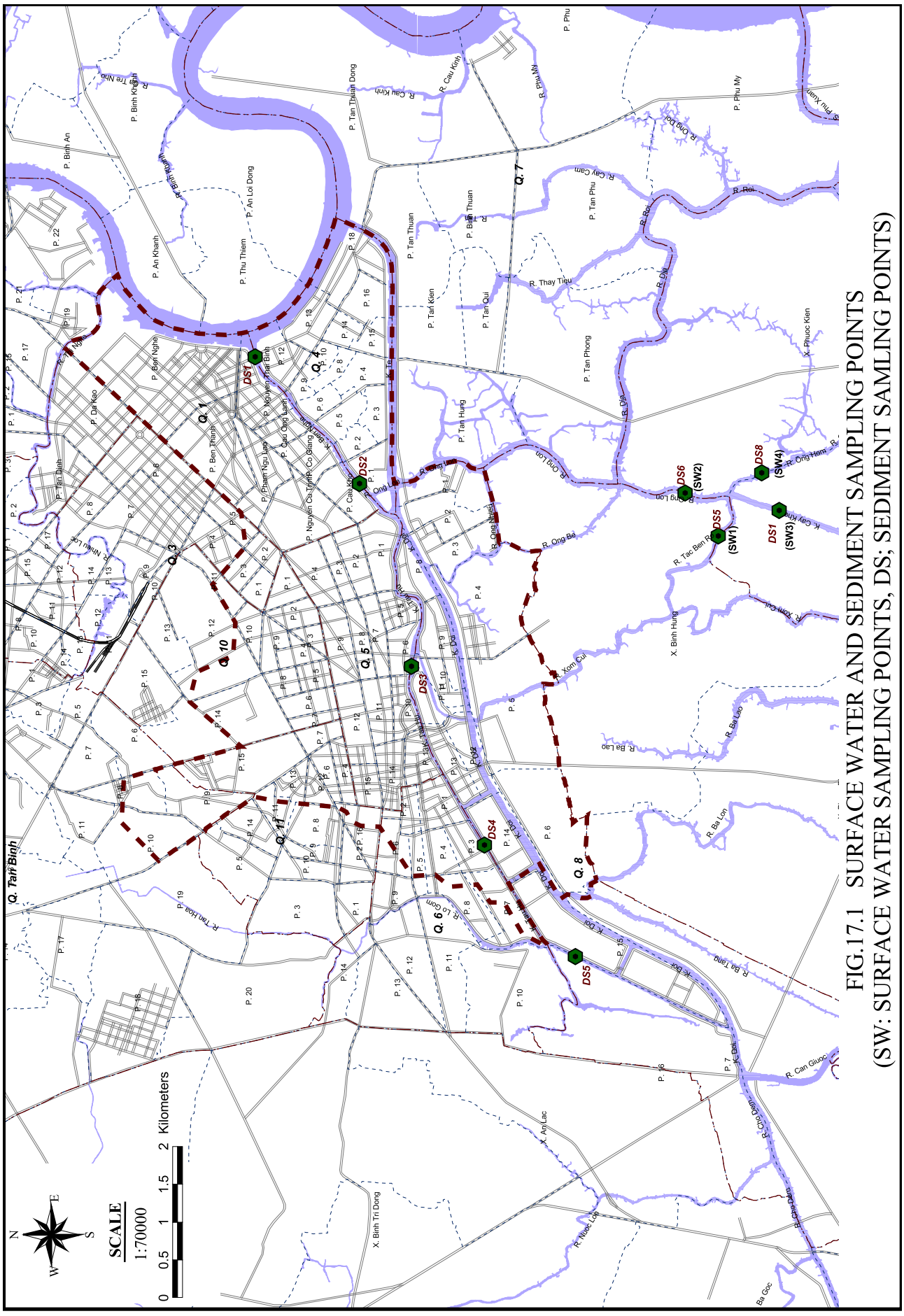


FIG.17.1 SURFACE WATER AND SEDIMENT SAMPLING POINTS
(SW: SURFACE WATER SAMPLING POINTS, DS; SEDIMENT SAMLING POINTS)

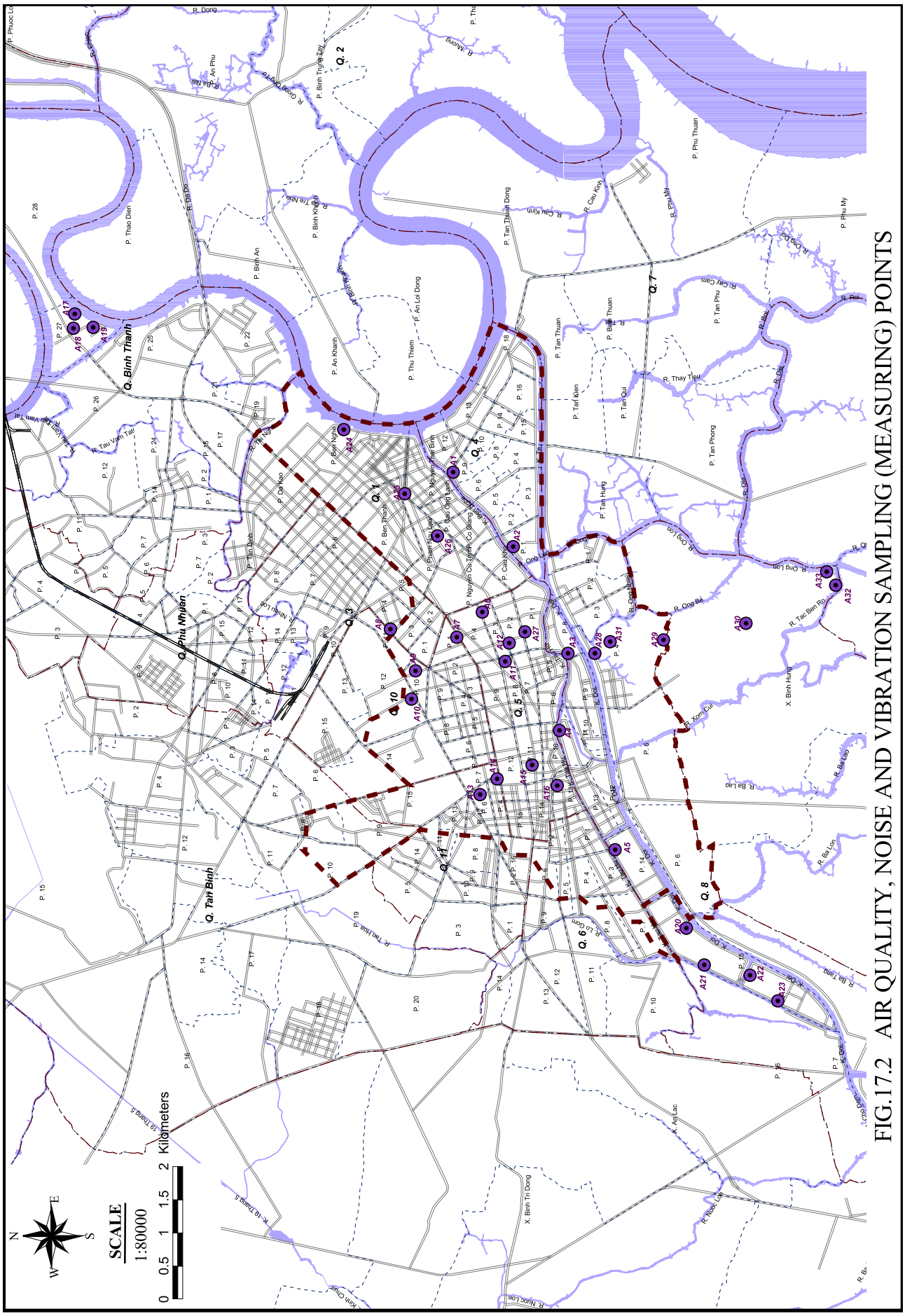


FIG.17.2 AIR QUALITY, NOISE AND VIBRATION SAMPLING (MEASURING) POINTS

Chapter 18

PILOT PLANT EXPERIMENTAL WORK

CHAPTER 18 PILOT PLANT EXPERIMENTAL WORK

18.1 General

In the Study of Urban Drainage and Sewerage System for Ho Chi Minh City, the modified aeration process has been proposed as the appropriate wastewater treatment process for the Phase I project.

Design standards for modified aeration process for the Phase I project could be determined by both Japanese or American Design Criteria. However, the modified aeration process has never been applied in either Vietnam or Japan. Therefore, experiment on wastewater treatment by pilot scale model plant is planned to obtain reference data for the design standards for modified activated sludge process.

18.2 Purpose of Experiment

The design criteria and operation condition of modified aeration process are shown in Table 18.1. The characteristics of modified aeration process are itemized as below:

Advantages of modified aeration process

- Aeration tank is smaller than that of conventional activated sludge method.
- Construction and operation cost is low.
- Convertibility to conventional activated sludge process or step aeration process is smooth.

Disadvantages of modified aeration process

- BOD and SS removal efficiency is low. Treatment level ranges between primary treatment and conventional activated sludge method.
- Flocculation of activated sludge is fragile. It is one of the causes of low BOD and SS removal efficiency.
- Excess sludge production is larger than that of conventional activated sludge method.
- Putrefaction of excess sludge arises easily.

Based on the information mentioned above, some items are selected as important design standards for determination of dimensions and capacity of treatment plant. This experiment is aimed to verify the following items of design standards for modified aeration process:

Items regarding aeration: F/M ratio
Aeration time

Items regarding final sedimentation tank: Surface loading

18.3 Contents of Experiment

(1) Outline

The experiment aims to verify the design standards for modified aeration process. Confirmation of convertibility to final process of step aeration process or conventional activated sludge process is also carried out. Therefore, three (3) treatment processes are operated as wastewater treatment experiment.

(2) Outline of Pilot Scale Model Plant

The pilot scale model plant consists of the following facilities:

- Primary sedimentation tank (according to the inflow water quality, primary sedimentation tank is not used.)
- Aeration tank (6 chambers x 2 sets)
- Final sedimentation tank (4 types surface area)

Flow diagram of pilot scale model plant and details of facilities are shown in Fig. 18.1.

(3) Location of Installation

The pilot scale model plant is installed in Cong Hoa Street, Tan Binh District from the point of view as described below (refer to Fig. 18.2):

- To obtain wastewater that has similar characteristics of design wastewater for the treatment plant (mainly domestic wastewater, refer to Table 18.2.).
- To obtain enough quantity of wastewater (maximum 40 L/min) for the experiment.
- Enough space for the installation of pilot scale model.
- No resident exists around the site (consideration of living condition).

(4) Experiment Condition (Operation Condition)

- Experiment condition has four different parts. Three parts are divided by treatment process. Objective treatment process is modified aeration process, step aeration process and conventional activated sludge process. Last part is the same operational condition as the Phase I Project.
- Three operation parameters are selected as design standards, namely food/microorganism ratio (F/M ratio), aeration time and surface loading of final sedimentation tank.
- Total number of experiment cases is eight (8). Four (4) cases are allocated to modified aeration process, two (2) cases are assigned for step aeration process. One (1) case is assigned for conventional activated sludge process, and one (1) case is set as same operational condition as the Phase I Project.

- Range of F/M ratio, aeration time and surface loading of final sedimentation tank for experiment condition are decided based on the design criteria.

According to the above mentioned point of view, experiment condition is determined as shown in Table 18.3.

(5) Analysis and Measurement Items

Analysis and measurement items for experiment of wastewater treatment are shown in Table 18.4.

18.4 Results of Experiment

Characteristic of Inflow water quality

Temperature

Water temperature of inflow during experiment ranges from 24.5 ^{o}C to 30.5 ^{o}C with 28.7 ^{o}C in average. Monthly average air temperature from 1976 to 1997 is 28.7 ^{o}C in June and 27.9 ^{o}C in July in Tan Son Nhat, wastewater temperature is much the same as air temperature. (refer to Fig. 18.3.)

PH

pH in raw wastewater ranges from 8.0 to 5.6 with 6.9 in average. It seems that low value of pH is resulted by wastewater discharged from industry. However, negative effects on wastewater treatment by acidity is not remarkable. (refer to Fig. 18.4.)

BOD, COD

BOD in inflow ranges from 123 mg/l to 158 mg/l with 142 mg/l in average, and COD ranges from 196 mg/l to 268 mg/l with 232 mg/l in average. It could be said that raw wastewater quality is identified as general characteristic of domestic wastewater.

SS

SS in inflow ranges from 140 mg/l to 230 mg/l with 100 mg/l in average. In comparison with variation of BOD and COD, sharp fluctuation in SS is recognized. It seems that the sharp fluctuation in SS is caused by inflow of rainwater.

(2) Results of Experiment

As mentioned above, three (3) treatment processes for experiment are selected, and eight (8) experiment cases are conducted from June to September 2000. Terms of experiment are shown in Fig. 18.5, and results of experiment are shown in Table 18.5. and Fig. 18.6.
Results of wastewater treatment experiment are summarized below.

Modified aeration process (from case-1 to case -4)

In the experiment of modified aeration process, F/M ratio, Aeration time, MLSS and surface loading in final sedimentation tank are selected for operation factors. F/M ratio, Aeration time and MLSS are operation factors in aeration tank, these are closely related to each other. The results of analysis are shown below.

Case	F/M ratio (BOD-kg/SS-kg/day)	Aeration time (hr.)	MLSS (mg/l)	C_At	Removal Efficiency* (%)		
					BOD	COD	SS
Case-1	6.3	1.0	540	540	65	48	-
Case-2	3.2	2.0	530	1,060	72	57	-
Case-3	2.2	3.0	530	1,590	73	65	-
Case-4	1.8	2.0	970	1,940	82	71	29

*: removal efficiency is estimated by water quality between inflow to aeration tank and outflow from final sedimentation tank.

In operation condition of case-1 with large value of F/M ratio (6.3 BOD-kg/SS-kg/day), removal efficiency in BOD obtains approximately 65 percent. While, in operation condition of case-4 with small value of F/M ratio (1.8 BOD-kg/SS-kg/day), it is approximately 82 percent. In case-4, BOD in inflow and treated wastewater are 144 mg/l and 26 mg/l respectively. Relationship between F/M ratio and BOD removal efficiency is evaluated and shown in Fig. 18.7.

Concerning aeration time and MLSS, removal efficiency of modified aeration process is evaluated. Generally, CAt is selected as parameter concerning aeration time and MLSS. CAt is obtained by multiplying aeration time (hr.) by MLSS (mg/l). Relationship between CAt and BOD removal efficiency is shown in Fig. 18.8.

It is clear that removal efficiency in BOD and COD is improved by reduction of F/M ratio and increase of aeration time and MLSS. However, in experiment from case-1 to case-4, particle of suspended solid in final sedimentation tank flow out. Consequently, SS concentration in treated wastewater is very high, removal efficiency in SS is not obtained. This matter will be considered and described in later section "Same operation condition as design condition of Phase I".

Step aeration process (from case-5 to case-6)

Experiment of case-5 and case-6 is carried out in order to confirm the convertibility to step aeration process. The results of experiment are shown below.

Case	F/M ratio (BOD-kg/SS-kg/day)	Aeration time (hr.)	MLSS (mg/l)	C_At	Removal Efficiency* (%)		
					BOD	COD	SS
Case-5	0.6	3.0	1,880	5,640	80	75	37
Case-6	0.4	3.0	2,870	8,610	83	74	46

MLSS concentration in step aeration process is kept higher than MLSS in modified aeration process. Accordingly, F/M ratio in step aeration process is twenty (20) percent, and CAt is five (5) times higher that modified aeration process. Based on the result of experiment, BOD removal efficiency in case-5 and case-6 are 80 percent and 83 percent respectively. (refer to Fig.18.7 and Fig.18.8)

It is clear that in the same pilot scale model plant, removal efficiency of step aeration process is equal or higher than modified aeration process.

Conventional aeration process (case-7)

Modified aeration process stands in the middle position in biological wastewater treatment process by its removal efficiency. While, conventional activated sludge process stands first in treatment process. This process is established as satisfactory and stable treatment process by sufficient case study and operation data.

In this experiment, conventional activated sludge process is carried out for comparison. The results of experiment are shown below.

Case	F/M ratio (BOD-kg/SS-kg/day)	Aeration time (hr.)	MLSS (mg/l)	C_At	Removal Efficiency* (%)		
					BOD	COD	SS
Case-7	0.3	6.0	2,100	12,600	85 (21mg/l)	81 (44mg/l)	78 (25mg/l)

Note: experiment term is from 28 Aug. to 1 September 2000.

Removal efficiency in BOD and SS are 21 mg/l and 25 mg/l respectively. It can be said that treated water quality is up to the standard of biological wastewater treatment process.

Same Operation Condition as Design Condition of Phase I (case-8)

Experiment condition in this case is same as design condition of Phase I Project. This case is carried out for confirmation of removal efficiency of modified aeration process, and basically, operation condition in this case is the same as case-3. Experiment condition and results are shown below.

(Operation Condition)

F/M ratio : 2.2 BOD-kg/SS-kg/day
Aeration time : 3.0 hr.
MLSS: 500 – 520 mg/l
C_At : 1,500 – 1,560
Surface loading in final sedimentation tank
Case-8-1 : 26 m^3/m^2/day
Case-8-2 : 14 m^3/m^2/day

Supplement Case 8.A : 58 m^3/m^2/day
Supplement Case 8.B : 41 m^3/m^2/day

(Parameter for operation)

SV_{30} :	230 %
SVI :	427
Sludge Age :	0.6

(Removal efficiency in aeration tank and final sedimentation tank)

Inflow	BOD	139 – 141 mg/l
	COD	226 – 229 mg/l
	SS	94 -112 mg/l
Outflow	BOD	35 mg/l
	COD	73 mg/l
	SS	26 - 28 mg/l
Removal efficiency		
	BOD	75 %
	COD	69 %
	SS	75 %

Note: Value is average in Case-8-1 and Case-8-2.

Based on the results of experiment, the following knowledge is obtained.

Relationship between surface loading in final sedimentation tank and SS removal efficiency

Surface loading in final sedimentation tank of experiment condition for case-8 and supplement case-8 ranges from 26 m^3/m^2/day to 58 m^3/m^2/day.
Based on the result of experiment, SS removal efficiency ranges from 64 % to 77 %, and SS concentration in treated wastewater ranges from 26 mg/l to 38 mg/l. It can be said that satisfactory removal efficiency is obtained in above operation condition.

SVI(sludge volume index) is too high.

Based on the results of experiment through all cases, large values of SVI are observed. Generally, large value of SVI is caused by following items.

- Sharp fluctuations of inflow water quality as BOD, pH.
- Inflow of hazardous or toxic substances
- Low temperature
- Operation : excessive F/M ratio, shortage of MLDO, excessive sludge age

According to the results of experiment, a cause of large value of SVI is still unknown.
In case of case-8 experiment, large value of SVI is measured. However, SV_{30} is 230 percent in average, because of MLSS concentration is approximately 500 mg/l. (refer to FIG.18.9.) Therefore, it seems that obstruction of treatment in final sedimentation tank is not occurred by large value of SVI.

Flocculation of activated sludge in modified aeration process.

Based on the experiment in case-1 to case-4, it is confirmed that minute particles of suspended solid in final sedimentation tank flow into treated wastewater.

Usually, MLDO (mixed liquor dissolved oxygen) is controlled from 2 mg/l to 3 mg/l at exit of aeration tank. However, large amount of air is needed for maintaining expected MLDO, because the depth of aeration tank in pilot scale model plant is very shallow. Consequently, it seems that deflocculation is dispersed by strong aeration. In order to improve SS concentration in treated wastewater, air volume is decreased to prevent dispersion of sludge flocculation in case-8. As a result, SS of treated wastewater in case-8 is improved from more than 100 mg/l to approximately 30 mg/l.

However, it can not be concluded that flocculation in modified aeration process is fragile by above mentioned.

Aeration tank is smaller than that of conventional activated sludge process

On the limited removal efficiency, namely it is around 70 percent or so, aeration time of modified aeration process is smaller than that of conventional activated sludge process. Therefore, it can be said that modified aeration process is very valuable treatment process in transitional period from the beginning to the end of development stage.

Convertibility to conventional activated sludge process or step aeration process

Based on the results of case-5, case-6 and case-7, convertibility to conventional activated sludge process or step aeration process is confirmed.

Treatment level ranges between primary treatment and conventional activated sludge method.

According to the experiment in case-1 to case-4, removal efficiency of modified aeration process in BOD ranges from 65 percent to 82 percent. As mentioned above, modified aeration process stands in middle position in biological wastewater treatment process by its removal efficiency.

Excess sludge production is larger than that of conventional activated sludge method

No available data in this experiment.

(3) Result of Sludge Test

Based on result of sludge thickening test, characteristic of sludge thickening in modified aeration process is obtained as below. (refer to Table 18.6)

- Appropriate thickening time for excess sludge is approximately 12 hours.
- Maximum concentration of thickened sludge by gravity thickening is approximately 10,000 mg/l (1%). Generally, concentration of thickened sludge ranges from 2 % to 4 %. (However, consolidation layer in sludge test is about 30 cm.)

- Putrefaction of excess sludge was occurred within 24 hours and thickened sludge rose to the surface.

From above mentioned, it is found that thickening ability of excess sludge in modified aeration process is poor.

18.5 Conclusion

(1) Comparison with Design Criteria

Comparison between Design Criteria and knowledge from wastewater treatment experiment is shown as below.

Items	Design Criteria	Design Condition for Phase I	Result of Experiment
F/M ratio (BOD-kg/SS-kg/day)	1.5 – 3.0	1.2 – 3.9	2.2
MLSS (mg/l) 400 - 800	400 - 800	500	
Sludge Age (day)	0.3 – 0.5	0.3 – 0.7	0.8
Air to flow ratio (times)	2 - 4	-	-*
Aeration time (hr.)	1.5 – 2.5	2.7	3.0
Return sludge ratio (%)	5 - 10	5 - 10	100
Surface loading in FST ($m^3/m^2/day$)	20 – 30	27.1	26 – 58
Removal efficiency as BOD (%)	50 – 60	64**	75***
Expected water quality in treated wastewater (BOD mg/l)	70 – 56**	50	35***
Expected water quality in treated wastewater (SS mg/l)	70 – 56**	70	30***

Note: * Air to flow ratio in experiment was not measured.
** Assuming that inflow water quality is 140 mg/l in BOD and SS respectively.
*** refer to Fig. 18.10 and Fig. 18.11.

From the above comparison, it is concluded that modified aeration process is an effective treatment process for Phase I project of wastewater treatment plant in HCMC.

However, it is necessary to pay attention to some points in design and operation. Attention points are mentioned below.

Deflocculation of activated sludge

It is not clear that deflocculation of activated sludge in modified aeration process is occurred easily or not. Based on the result of case -8 experiment, sufficient SS removal efficiency is verified. Therefore, fragileness of activated sludge in modified aeration process is not a fatal disadvantage. However, it is recommended that fragileness of activated sludge and suitable operation should be confirmed.

Poor thickening ability of excess sludge

From the following points of view, it can be said that thickening of excess sludge by gravity thickening tank is not the best solution.

- Poor thickening ability of excess sludge in modified aeration process.
- Water temperature ranges from 25°C to 30°C. Putrefaction of excess sludge will be accelerated by high temperature.

It is well known that supernatant liquor from malfunctioned gravity thickening tank often contains large amount of pollution load as BOD and SS, and its pollution load returns to the primary sedimentation tank. It is not only loss of energy but it is feared that deterioration or malfunction of treatment function is occurred.

Tendency for SVI to rise

Cause of high value of SVI in this experiment is unidentified. However, in case-8 experiment, it seems that obstruction of treatment in final sedimentation tank is not occurred by large value of SVI. Therefore, large value of SVI is also not a fatal disadvantage. Similarly, it is desired that large value of SVI and suitable operation will be considered.

TABLE 18.1 DESIGN CRITERIA AND OPERATION CONDITION

Operation Condition / Process	BOD Loading		MLSS	Sludge Age	Aeration time
	BOD-SS Loading (BOD-kg /SS-kg/day)	BOD-Volume Loading (BOD-kg /m3/day)	(mg/l)	(day)	(hr.)
Conventional Activated Sludge Process	0.2 - 0.4	0.3 - 0.8	1,500 - 2,000	2 - 4	6 - 8
Step Aeration Process	0.2 - 0.4	0.4 - 1.4	2,000 - 3,000	2 - 4	4 - 6
Modified Aeration Process	1.5 - 3.0	0.6 - 2.4	400 - 800	0.3 - 0.5	1.5 - 2.5

Source: 'Design Criteria' Japan Sewage Works Association (1972)

TABLE 18.2 CHARACTER OF RAW SEWAGE FOR EXPERIMENT ON WASTEWATER TREATMENT

Items		Results (Date of Sampling : 27 April 2000)			
Sampling time		7:35	12:05	16:10	Average
pH		6.1	5.6	6.1	5.9
COD_{Cr}	(mg/l)	155	287	314	252
BOD_5	(mg/l)	83.7	162	179	142
SS	(mg/l)	120	140	110	123
NH4-N	(mg/l)	4.2	8.3	6.7	6.4
PO4-P	(mg/l)	8.2	7.6	7.9	7.9

Source : This survey is carried out by JICA.

TABLE. 18.3. EXPERIMENT CONDITION OF WASTEWATER TREATMENT

Case	Inflow (L/min.)	P.S.T.	Aeration Tank				F.S.T.
		Treated or non.	MLSS (mg/l)	Aeration time (hr.)	BOD-SS Loading (BOD kg/SS kg/d.)	Treatment Process	Surface Loading* ($m^3/m^2/d.$)
1	20	non.	500	1	6.7	Modified	25.5
2	20	non.	500	2	3.4	Modified	25.5
3	20	non.	500	3	2.2	Modified	40.6 - 57.6
4	20	non.	1,000	2	1.7	Modified	25.5 - 40.6
5	20	non.	2,000	3	0.6	Step	14.3
6	20	non.	3,000	3	0.4	Step	25.5
7	10	non.	2,000	6	0.3	Conventional	20.3 - 12.8
8	20	non.	500	3	2.2	Modified	14.3 - 25.5
Supplementary	20	non.	500	3	2.2	Modified	40.6 - 57.6

P.S.T. : Primary Sedimentation Tank
F.S.T. : Final Sedimentation Tank
Modified : Modified Aeration Process
Step Step Aeration Process
Conventional Conventional Activated Sludge Process
* : not including return sludge

TABLE 18.4. ANALYSIS AND MEASUREMENT ITEMS

Analyzed items	Sampling point	Note
Temperature	Inflow, Outflow	A,F
pH	Inflow, Outflow	A,F
MLSS	Aeration tank	C
MLVSS	Aeration tank	C
MLDO	Aeration tank	C
SV (5,10,15,20,30,45,60min)	Aeration tank	C
T-BOD	Inflow, Outflow from Prim. & Final sed.tank	A,B,E
S-BOD	Inflow, Outflow from Prim. & Final sed.tank	A,B,E
T-COD_{Cr}	Inflow, Outflow from Prim. & Final sed.tank	A,B,E
S-COD_{Cr}	Inflow, Outflow from Prim. & Final sed.tank	A,B,E
SS	Inflow, Outflow from Prim. & Final sed.tank	A,B,E
Flow	Inflow, Return sludge, Excess sludge	A,D,F
Sludge density	Return sludge, Excess sludge	D,F

Note : refer to FIG. W.1

TABLE 18.5. RESULT OF WASTEWATER TREATMENT EXPERIMENT

Case	Process	F/M ratio BDD-kg/SS-kg/d.	Aeration Time hr.	MLSS mg/l	Surface Loading in Final Sed. T.($m^3/m^2/d.$) Net*	Surface Loading in Final Sed. T.($m^3/m^2/d.$) Gross*	SV_{30} (%)	SVI	Sludge Age (day)	SRT (day)
Case-1	Modified A.P.	6.3	1.0	540	25.5	38.2	192	355	0.3	0.4
Case-2	Modified A.P.	3.2	2.0	530	25.5	38.2	159	299	0.6	0.5
Case-3	Modified A.P.	2.2	3.0	530	57.6	100.8	167	314	0.6	0.5
Case-4	Modified A.P.	1.8	2.0	970	40.6	60.9	269	277	0.7	0.8
Case-5	Step A.P.	0.6	3.0	1,880	14.3	28.7	907	482	4.7	5.5
Case-6	Step A.P.	0.4	3.0	2,870	25.5	51.0	812	283	7.2	6.9
Case-7 -1	Conventional A.S.P.	0.3	6.0	1,930	20.3	40.6	534	275	6.4	8.0
-2		0.3	6.0	2,100	12.8	25.5	610	291	5.0	9.7
Case-8 -1	Modified A.P.	2.2	3.0	500	25.5	51.0	186	370	0.8	1.3
-2		2.2	3.0	520	14.3	28.7	222	427	0.6	1.6
Suppl. 8 -A		2.2	3.0	520	57.6	115.2	151	294	0.6	1.2
-B		2.2	3.0	520	40.6	81.2	270	542	0.6	1.4

Case	Process	Inflow (mg/l) COD	Inflow (mg/l) BOD	Inflow (mg/l) SS	Outflow (mg/l) COD	Outflow (mg/l) BOD	Outflow (mg/l) SS	Removal Efficiency (%) COD	Removal Efficiency (%) BOD	Removal Efficiency (%) SS
Case-1	Modified A.P.	220	142	80	114	49	116	48	65	-
Case-2	Modified A.P.	221	142	83	96	40	103	57	72	-
Case-3	Modified A.P.	237	144	134	83	39	121	65	73	10
Case-4	Modified A.P.	237	144	139	68	26	99	71	82	29
Case-5	Step A.P.	239	144	52	59	29	33	75	80	37
Case-6	Step A.P.	239	144	52	61	24	28	74	83	46
Case-7 -1	Conventional A.S.P.	226	139	94	46	22	27	80	84	71
-2		229	141	112	44	21	25	81	85	78
Case-8 -1	Modified A.P.	226	139	94	73	35	26	68	75	72
-2		229	141	112	73	35	28	68	75	75
Suppl. 8 -A		230	141	107	63	32	36	73	77	66
-B		230	141	107	65	34	38	72	76	64

note: * Net surface Loading = Inflow volume (m^3/day) / surface area(m^2)

Gross surface Loading = (Inflow volume (m^3/day) + Return sludge volume(m^3/day)) / surface area(m^2)

Case-1: from 26 Jun. to 30 Jun.

Case-2: from 24 Jun. to 30 Jun.

Case-3,4: from 12 Jul. to 18 Jul.

Case-5,6: from 1 Aug. to 7 Aug.

Case-7,8-1: from 23 Aug. to 27 Aug.

Case-7,8-2 : from 28 Aug. to 1 Sep.

Supplementary Case-8-A,B : from 18 Sep. to 1 Oct.

TABLE 18.6 RESULT OF SLUDGE THICKENING TEST

(Thickening - Retention time)

		Modified Aeration		
	Time	Temp. (^{0}C)	SS (g/l)	DS(%)
1	0hr.	28.0	4.254	0.43
2	0.5hr.	28.0	4.804	0.48
3	1hr.	28.0	5.726	0.57
4	2hr.	28.5	6.132	0.61
5	3hr.	28.0	6.392	0.64
6	6hr.	28.5	7.946	0.79
7	12hr.	28.5	10.202	1.02
8	24hr.	28.0	8.608	0.86

(Thickening - Depth)

		Modified Aeration		
	Depth	Temp. (^{0}C)	SS(mg/l)	DS(%)
1	10cm	28.5	40	
2	20cm	28.5	40	
3	30cm	28.5	45	
4	40cm	28.5	45	
5	50cm	28.5	50	
6	60cm	28.5	50	
7	70cm	28.5	50	
8	80cm	28.5	50	
9	90cm	28.5	50	
10	100cm	28.5	50	
11	110cm	28.5	50	
12	120cm	28.5	440	0.04
13	130cm	28.5	8040	0.80
14	140cm	28.5	8530	0.85
15	150cm	28.5	8900	0.89

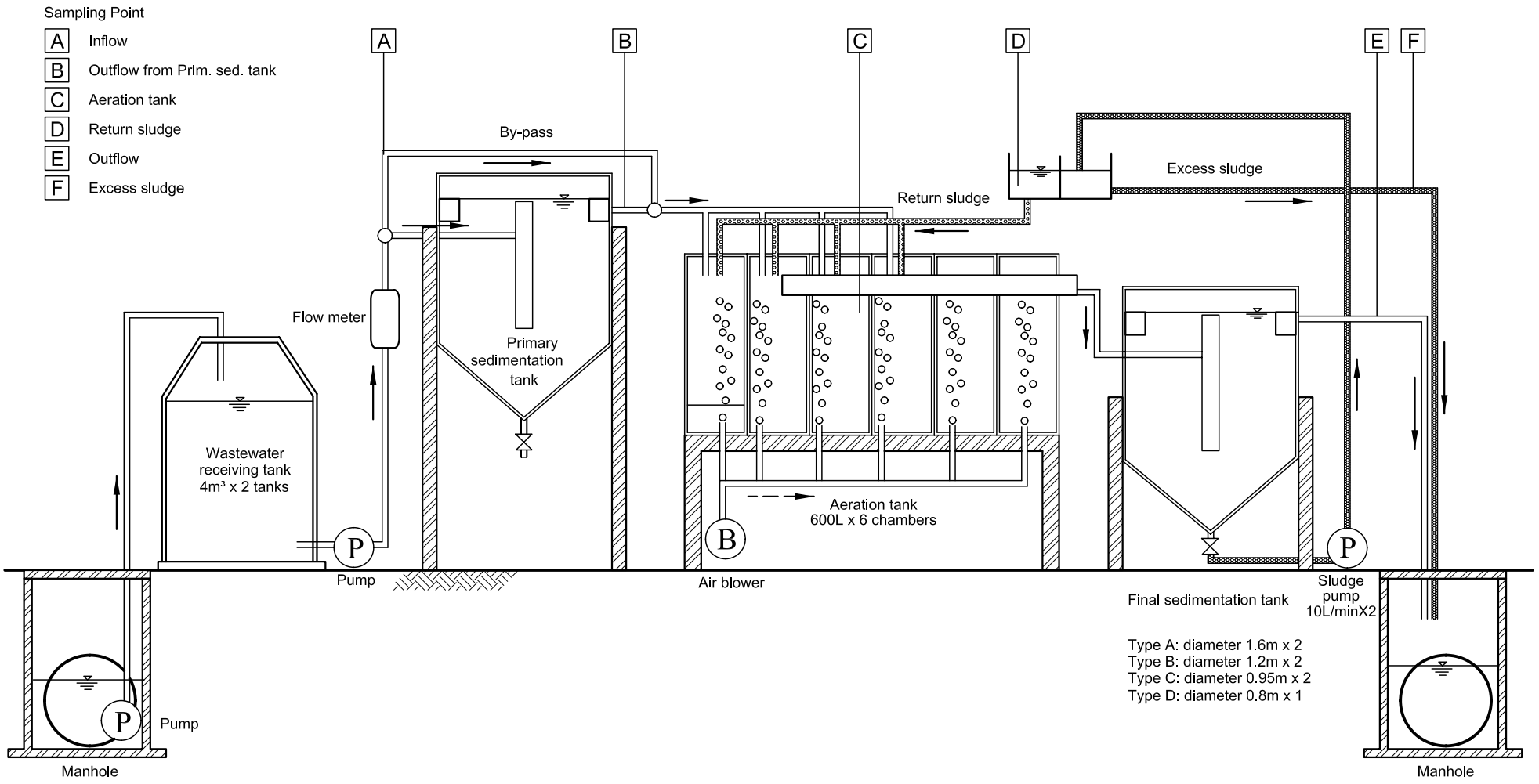


FIG. 18.1 FLOW-DIAGRAM OF PILOT SCALE MODEL PLANT

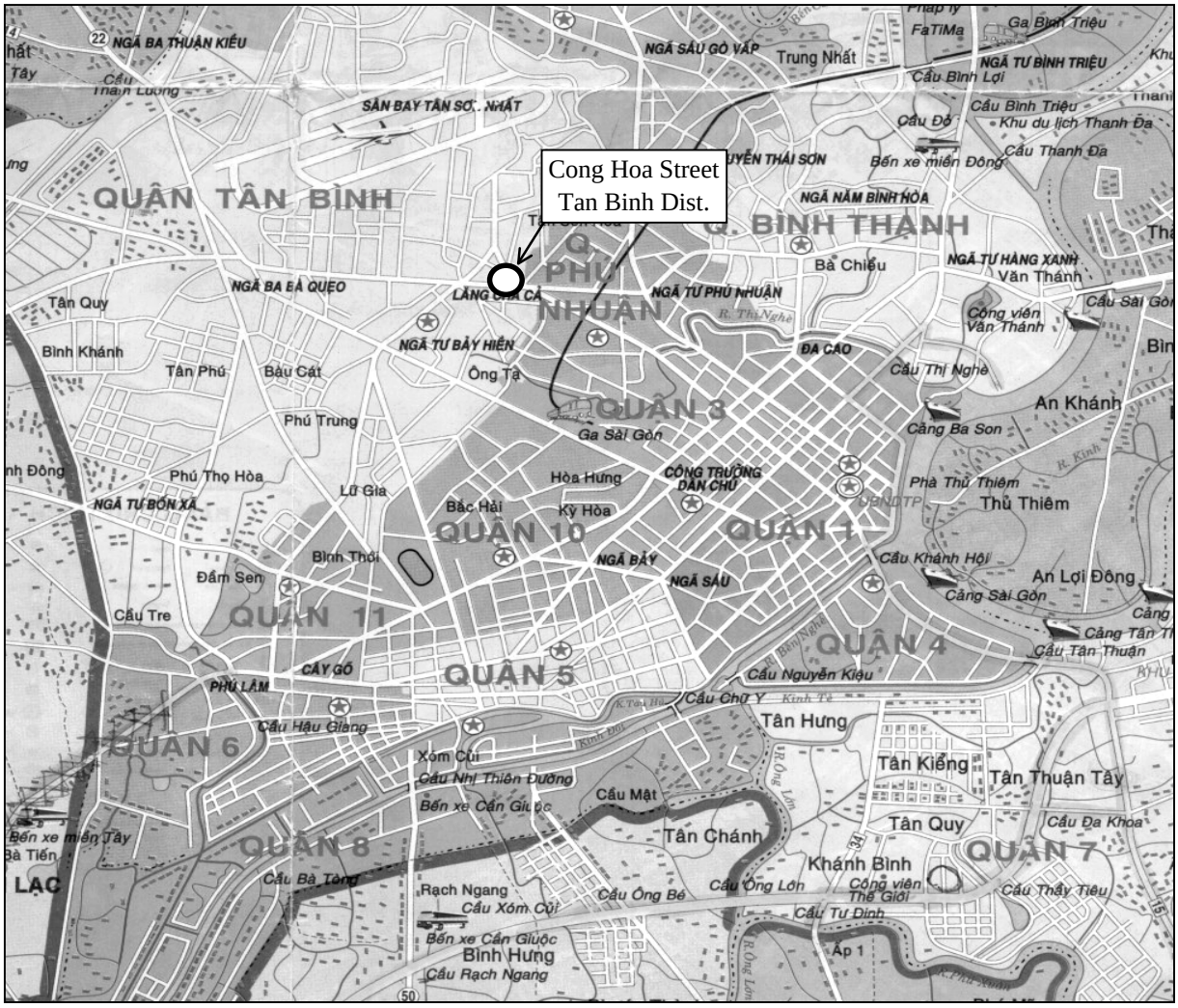


FIG. 18.2 LOCATION OF PILOT SCALE MODEL PLANT

Pilot scale model plant for wastewater treatment experiment

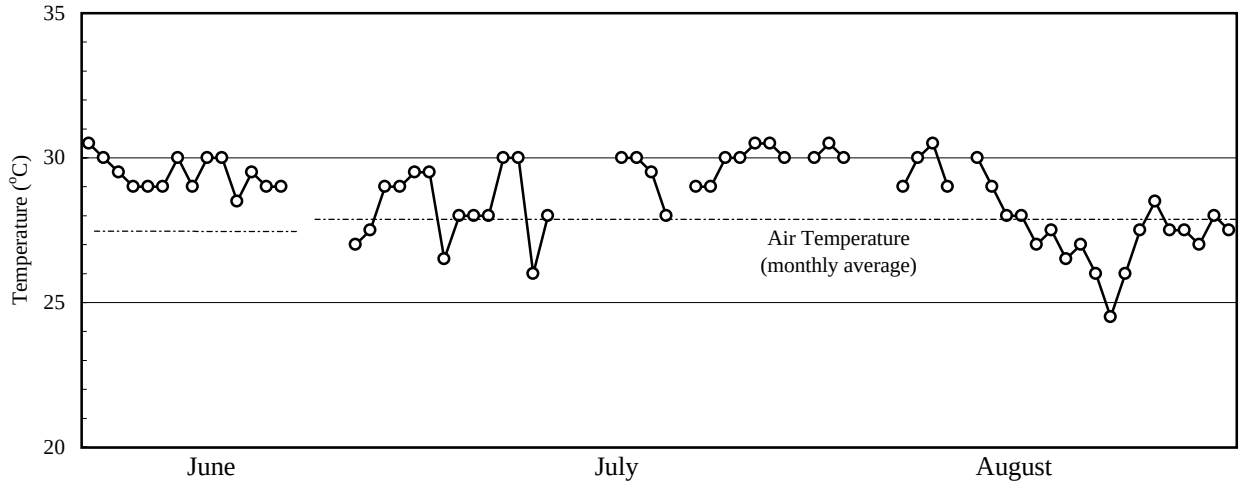


FIG.18.3 CHARACTERISTIC OF INFLOW (WATER TEMPERATURE)

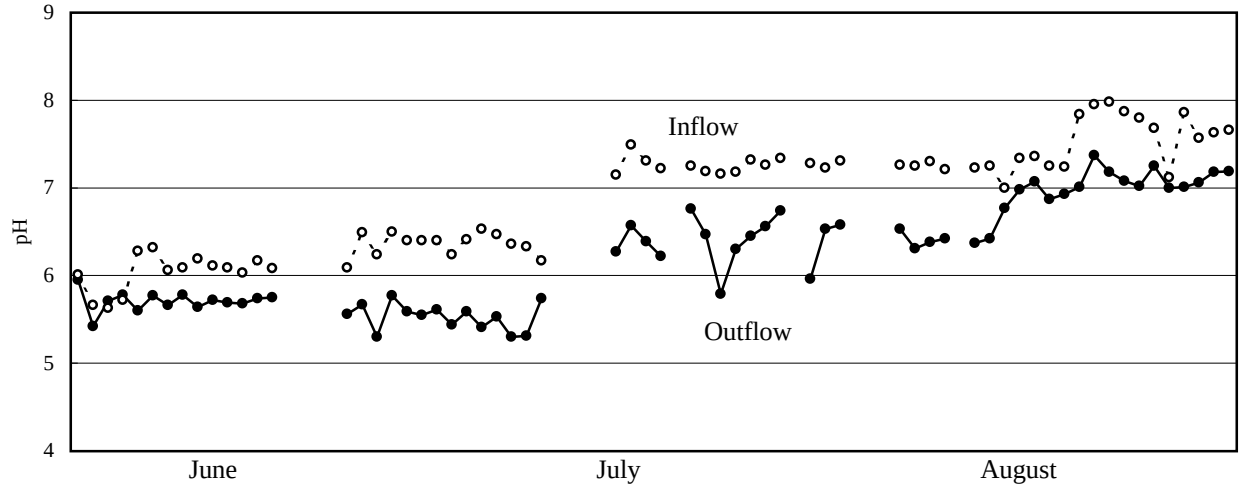


FIG.18.4 CHARACTERISTIC OF INFLOW (pH)

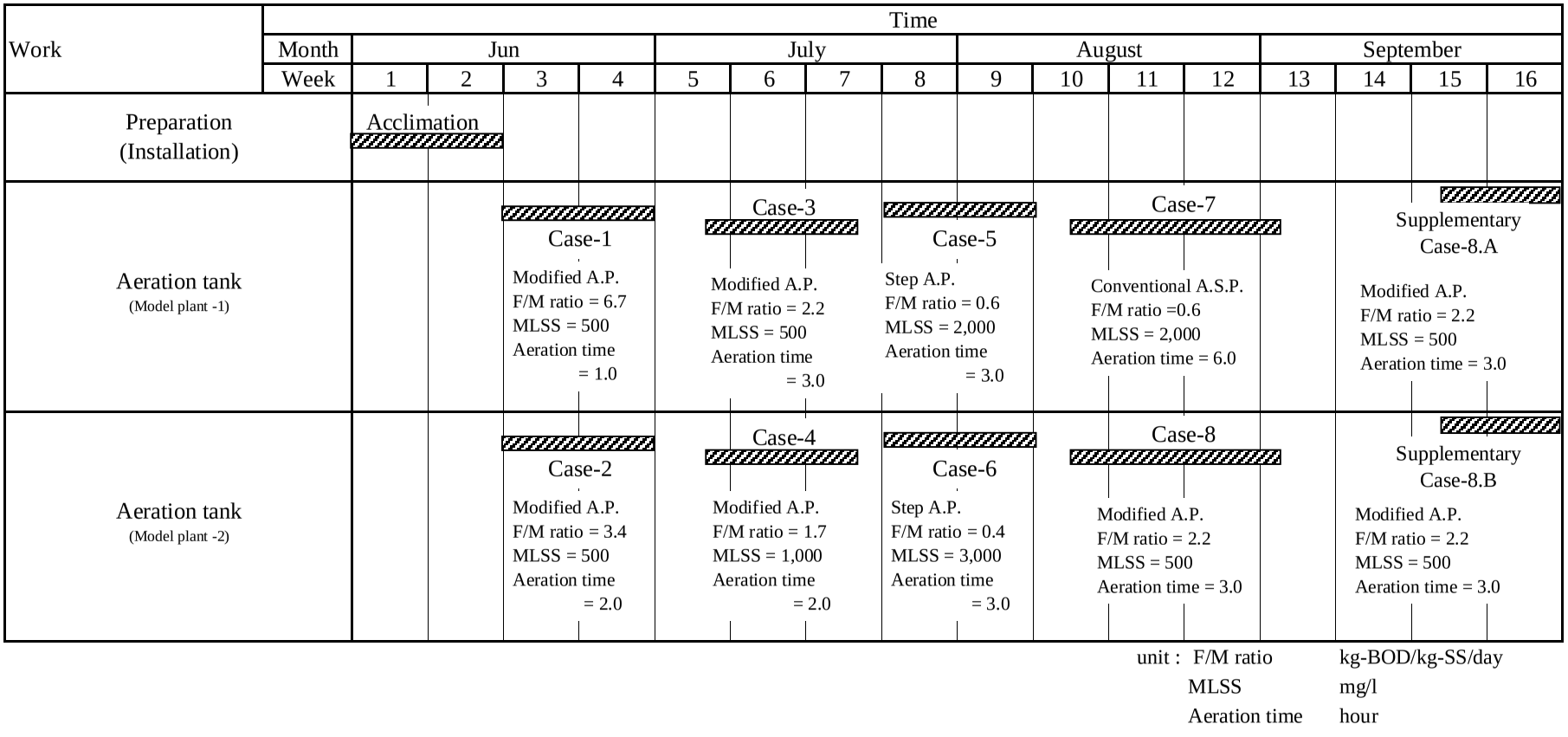
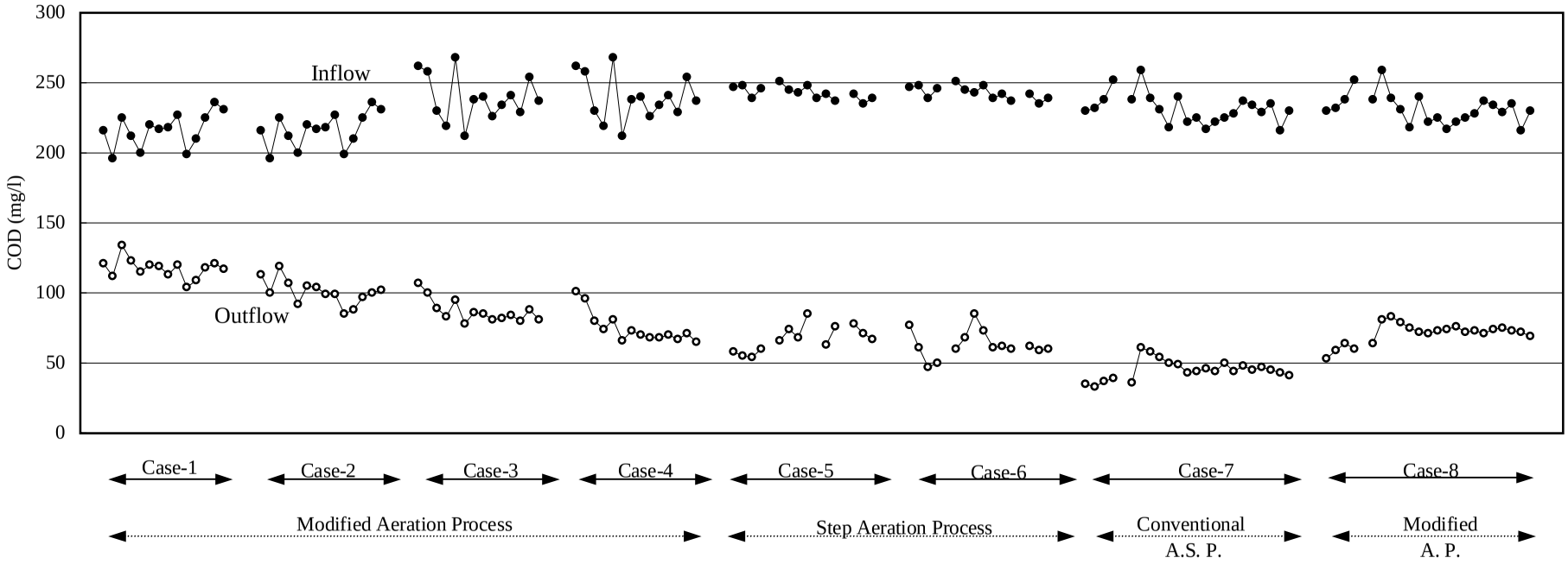


FIG.18.5 TERM OF WASTEWATER TREATMENT EXPERIMENT

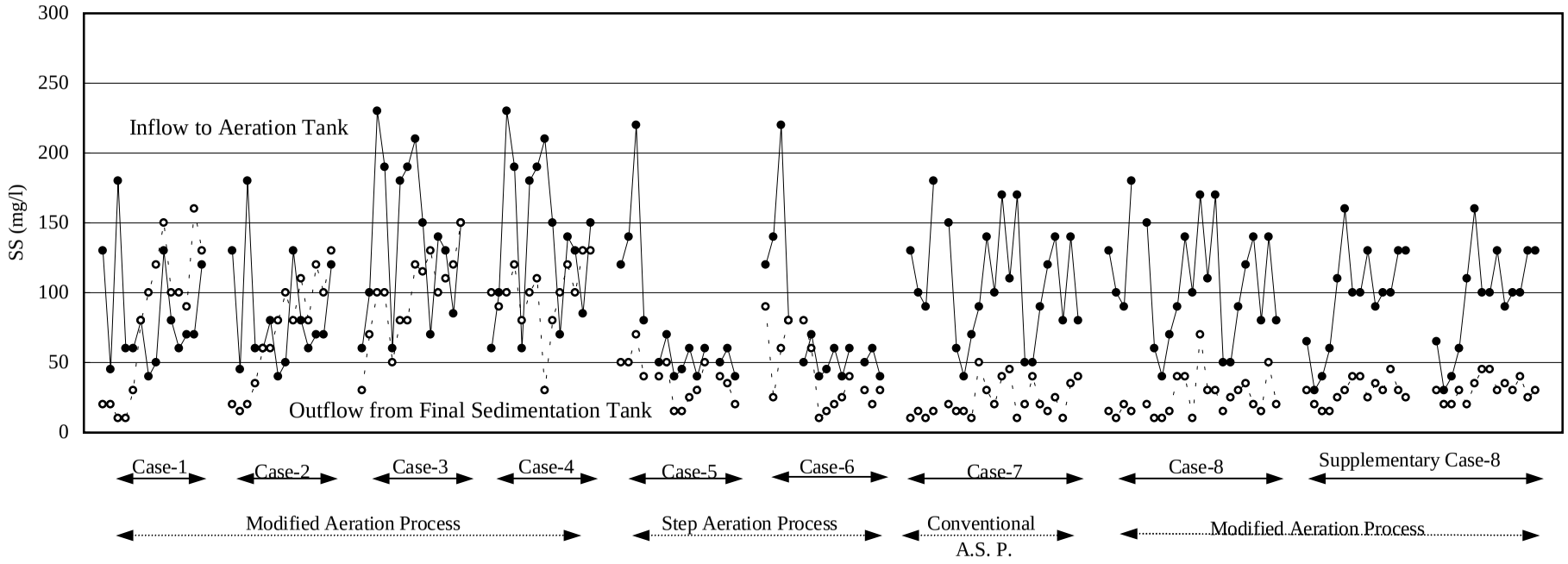
MLSS	540	530	530	970	1,880	2,870	1,930 - 2,100	500 - 520
Aeration Time (hr)	1.0	2.0	3.0	2.0	3.0	3.0	6.0	3.0
F/M Ratio (BOD-kg/SS-kg/day)	6.3	3.2	2.2	1.8	0.6	0.4	0.3	2.2

FIG. 18.6 (1/4) RESULT OF EXPERIMENT (BOD: INFLOW AND OUTFLOW)



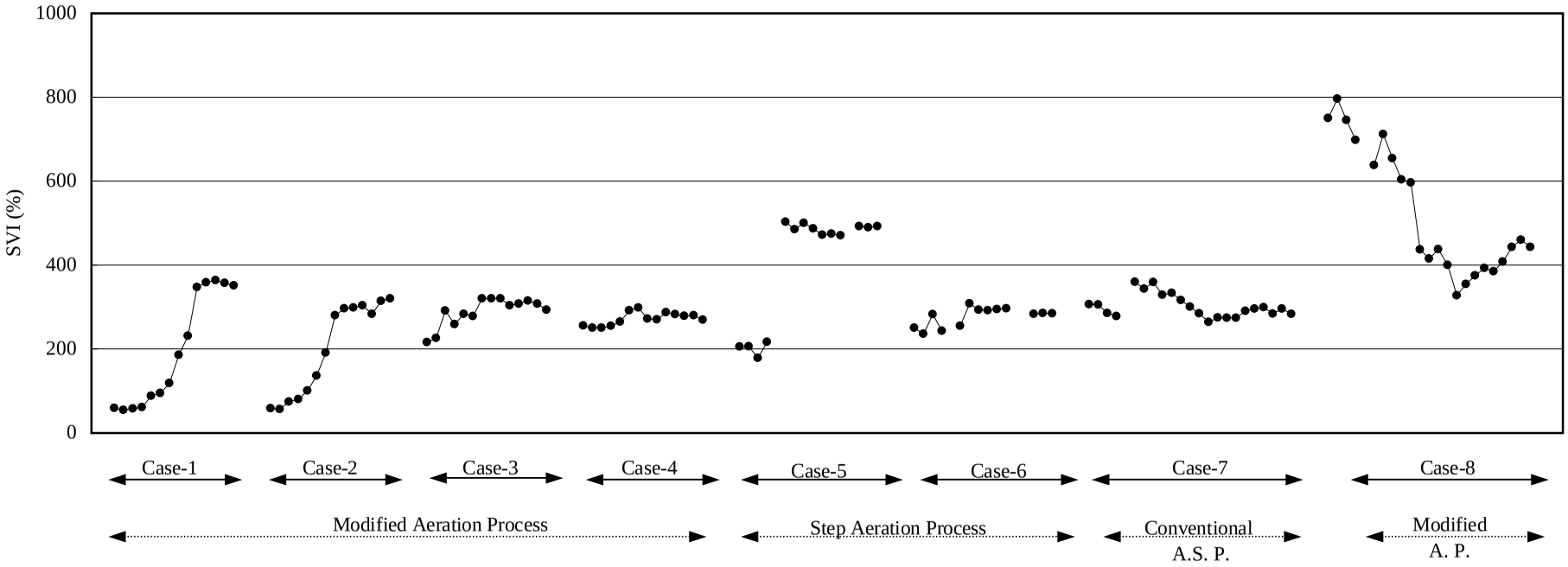
MLSS	540	530	530	970	1,880	2,870	1,930 - 2,100	500 - 520
Aeration Time (hr)	1.0	2.0	3.0	2.0	3.0	3.0	6.0	3.0
F/M Ratio (BOD-kg/SS-kg/day)	6.3	3.2	2.2	1.8	0.6	0.4	0.3	2.2

FIG. 18.6 (2/4) RESULT OF EXPERIMENT (COD: INFLOW AND OUTFLOW)



MLSS	540	530	530	970	1,880	2,870	1,930 - 2,100	500 - 520	
Aeration Time (hr)	1.0	2.0	3.0	2.0	3.0	3.0	6.0	3.0	
F/M Ratio (BOD-kg/SS-kg/day)	6.3	3.2	2.2	1.8	0.6	0.4	0.3	2.2	
Surface Loading (m^3/m^2/day)	25.5	25.5	57.6	40.6	14.3	14.3	12.8 - 20.3	14.3 - 25.5	40.6 - 57.6

FIG. 18.6 (3/4) RESULT OF EXPERIMENT (SS: INFLOW AND OUTFLOW)



MLSS	540	530	530	970	1,880	2,870	1,930 - 2,100	500 - 520
Aeration Time (hr)	1.0	2.0	3.0	2.0	3.0	3.0	6.0	3.0
F/M Ratio (BOD-kg/SS-kg/day)	6.3	3.2	2.2	1.8	0.6	0.4	0.3	2.2

FIG. 18.6 (4/4) OPERATION CONDITION OF EXPERIMENT (SVI)

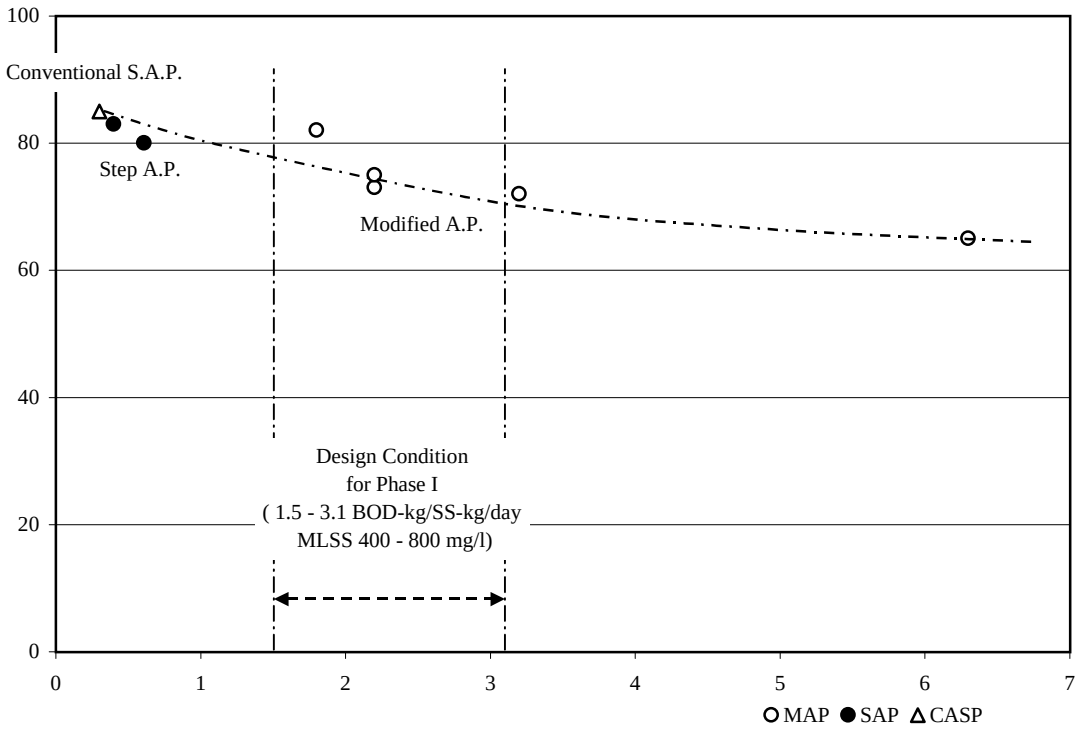


FIG. 18.7 RELATIONSHIP BETWEEN F/M RATIO AND REMOVAL EFFICIENCY

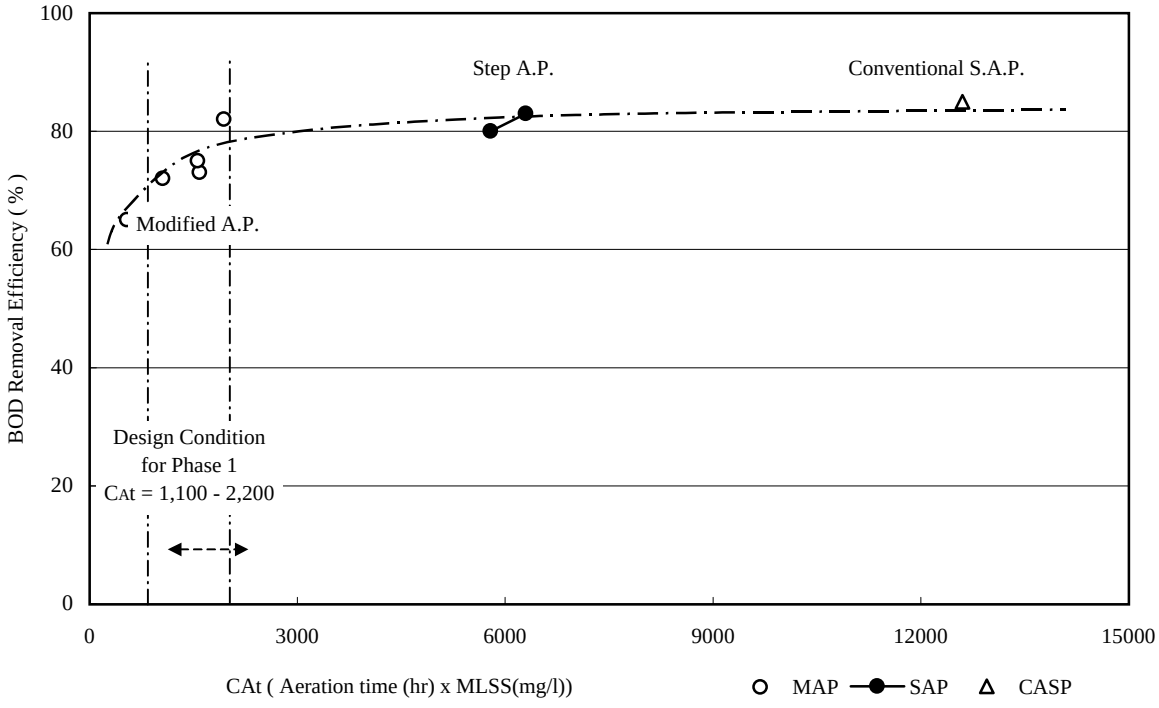


FIG. 18.8 RELATIONSHIP BETWEEN CAt AND REMOVAL EFFICIENCY

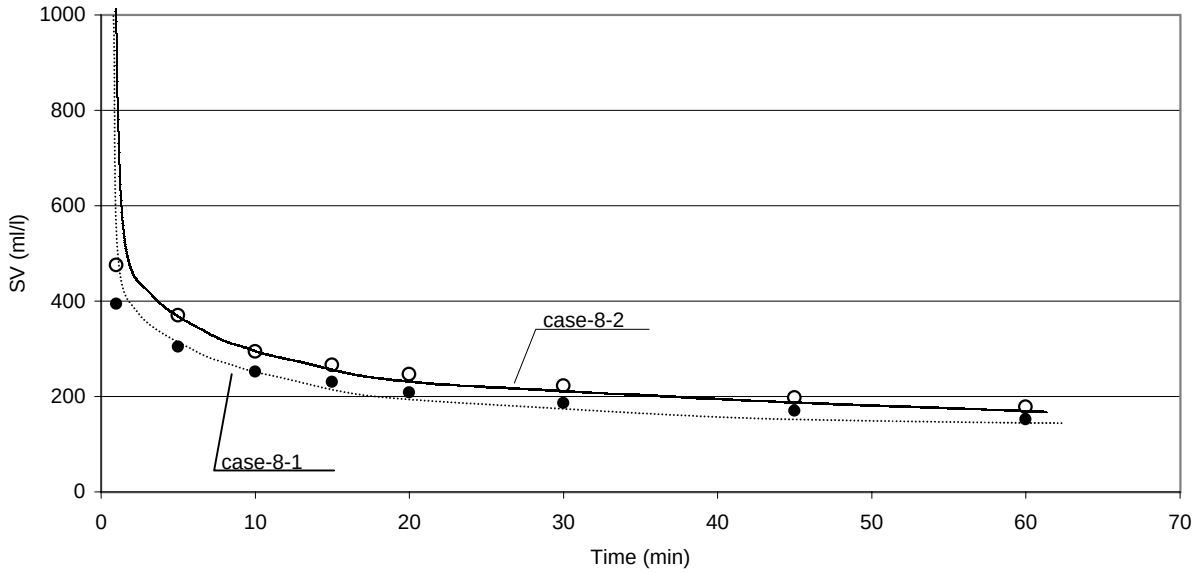
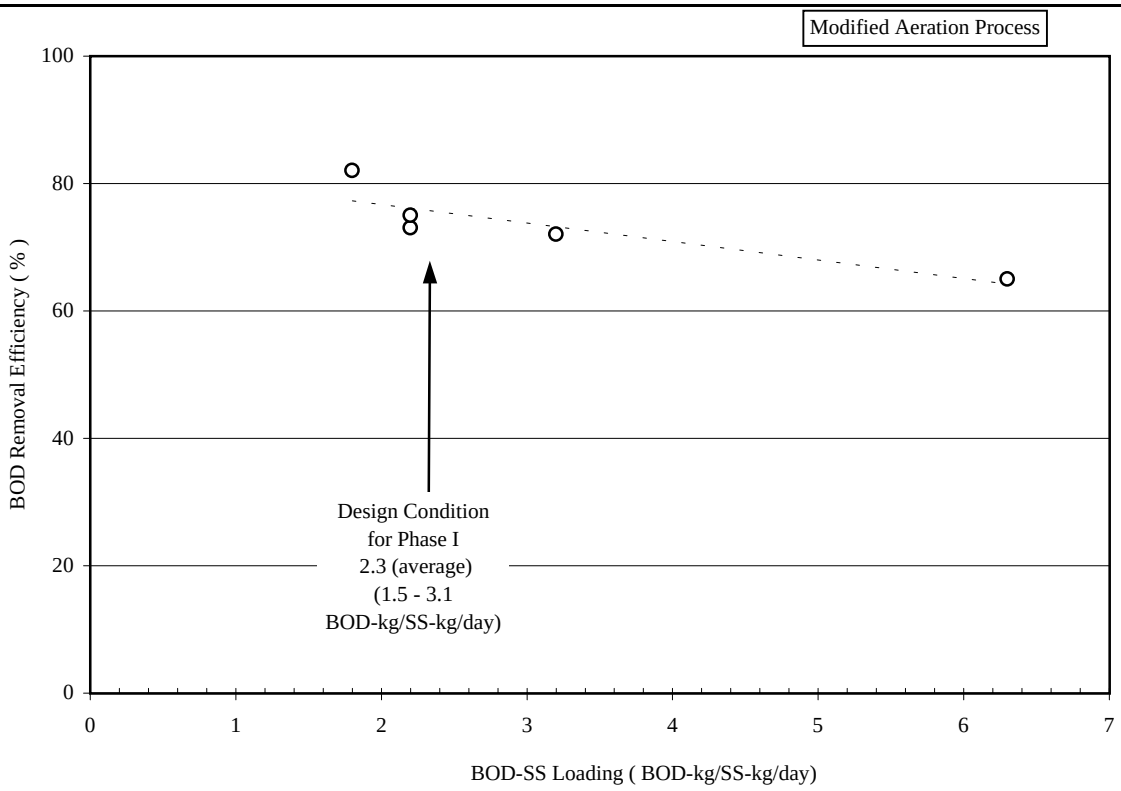
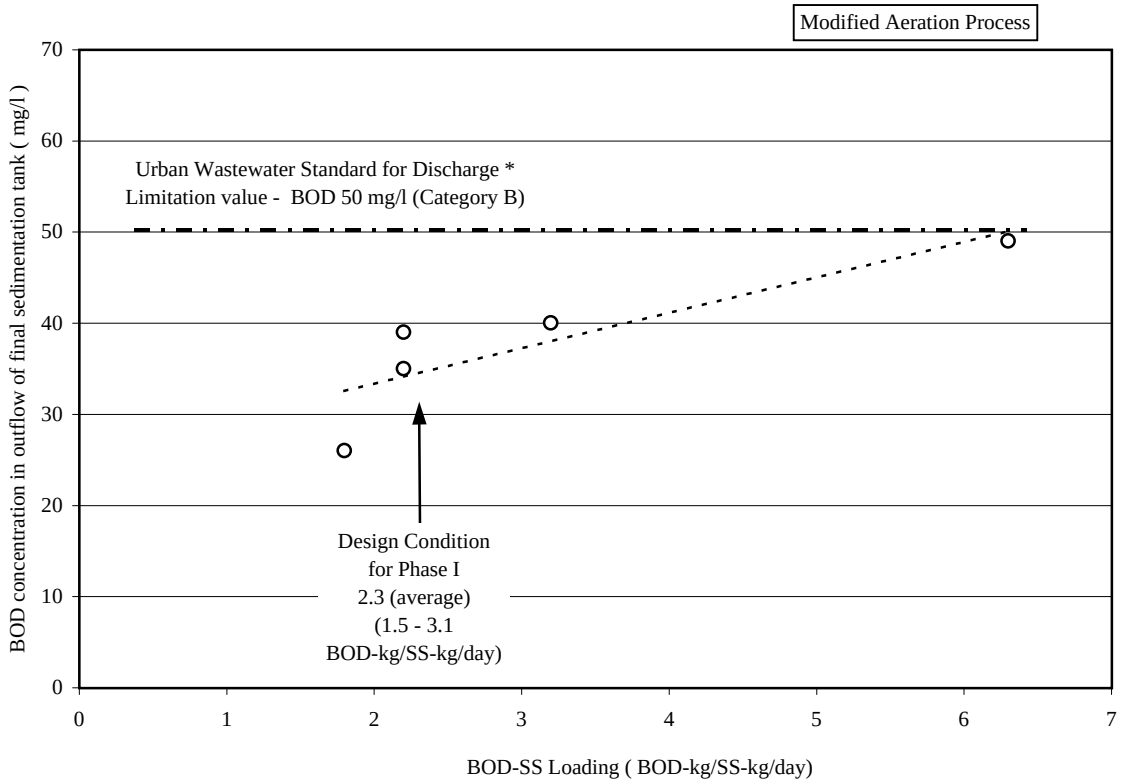


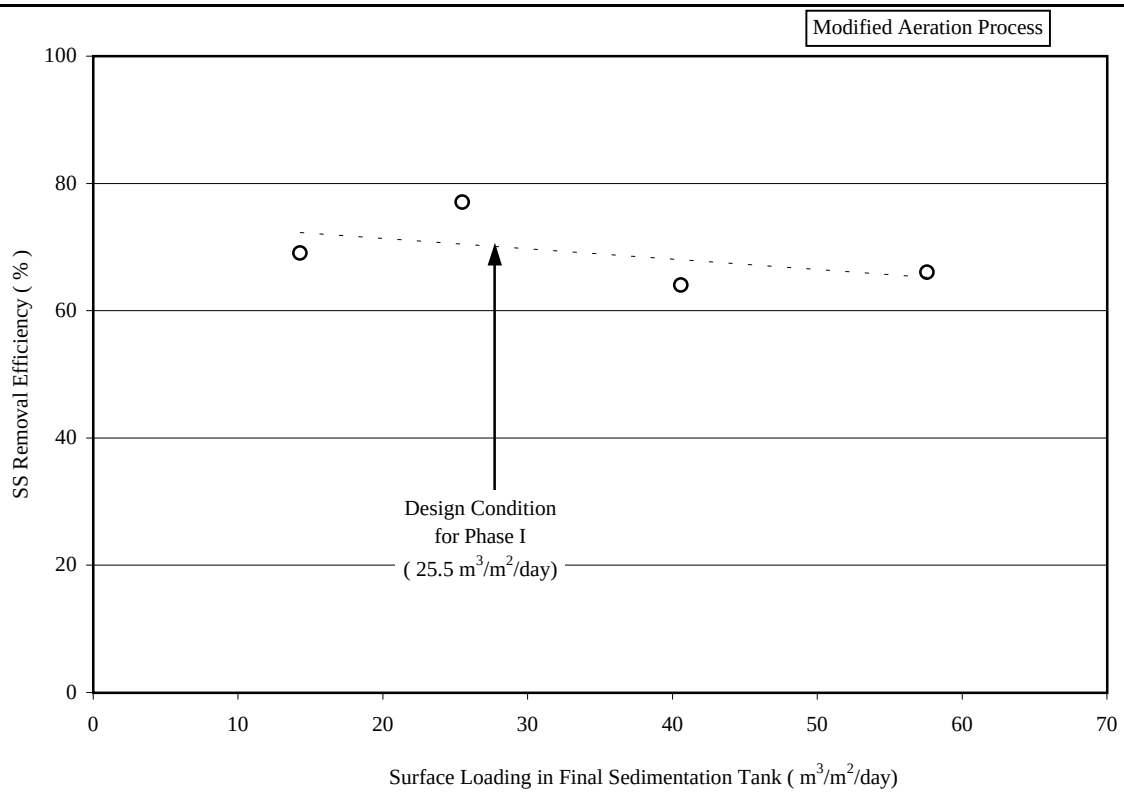
FIG. 18.9 SETTLING CURVE (MODIFIED AERATION PROCESS : CASE-8)

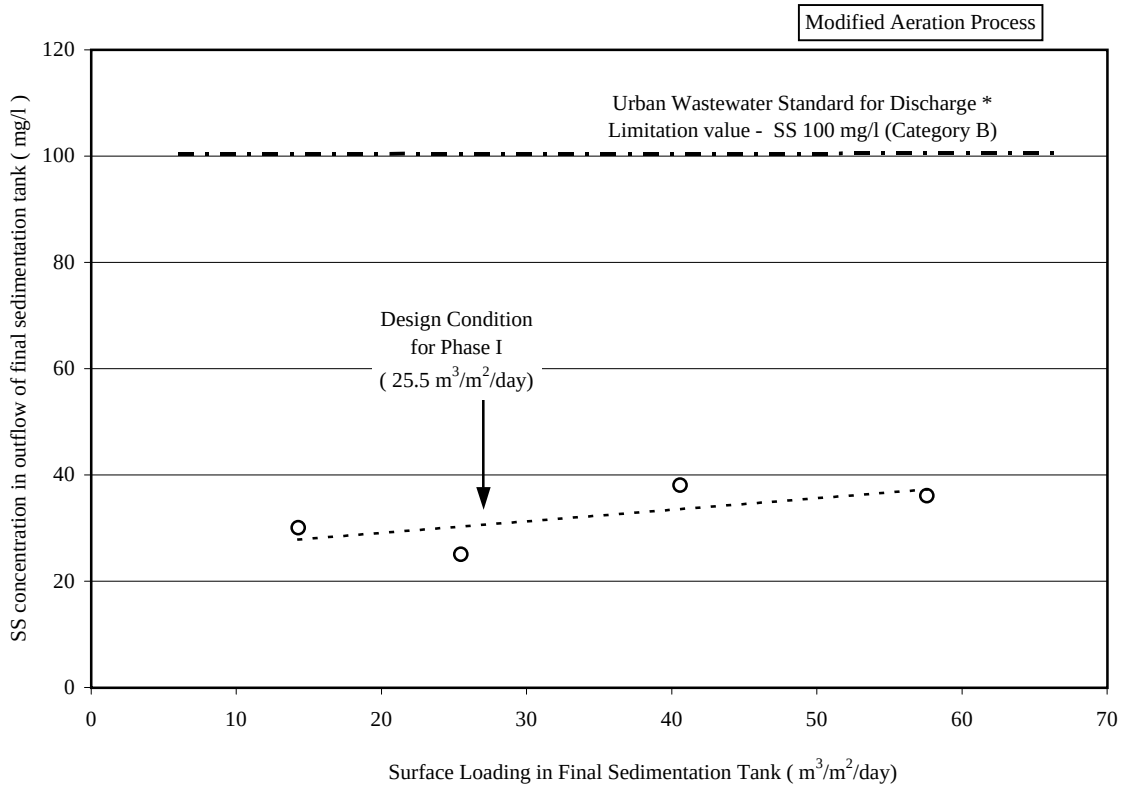




note: * Vietnam Standard (TCXD 188-1996)

FIG. 18.10 RELATIONSHIP BETWEEN F/M RATIO AND REMOVAL EFFICIENCY





note: * Vietnam Standard (TCXD 188-1996)

FIG. 18.11 RELATIONSHIP BETWEEN SURFACE LOADING IN FINAL SEDIMENTATION TANK AND REMOVAL EFFICIENCY