Japan International Cooperation Agency (JICA)

Hanoi People's Committee
Socialist Republic of Vietnam

The Study
on
Environmental Improvement for Hanoi City
in
The Socialist Republic of Vietnam

Final Report

Main Report
Volume 3

Environmental Master Plan
Recommended EMP and
Future Environmental Conditions

July 2000

Nippon Koei Co., Ltd.

EX Corporation

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LIST OF REPORTS

ESTIMATE OF PROJECT COST

Estimate of Base Cost : As of March 1999 Price Level
Currency Exchange Rate : USD1.0 = VND13,900 = Yen 122

THE STUDY
ON
ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY
IN
THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT

MAIN REPORT

Volume 3

Environmental Master Plan: Recommended EMP and Future Environmental Conditions

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ABBREVIATIONS

Government of Vietnam/Public Institutions

APNEH	:	Hanoi Association for Protection of Nature
CEETIA	:	Center for Environmental Engineering of Towns and Industrial Areas
CEST	:	Center for Environmental Science and Technology
DFP	:	Department of Finance and Pricing
DI	:	Department of Industry
DOC	:	Department of Construction
DOSTE	:	Hanoi Department of Science, Technology and Environment
EMD	:	Environmental Management Division
GOV	:	Government of Vietnam
HAPI	:	Hanoi Authority of Planning and Investment
HCAO	:	Hanoi Chief Architect's Office
HD	:	Healthcare Department
HPC	:	Hanoi People's Committee
HSDC	:	Hanoi Sewerage and Drainage Company
HT	:	Hanoi Television
MOC	:	Ministry of Construction
MOET	:	Ministry of Environment and Training
MOF	:	Ministry of Finance
MOI	:	Ministry of Industry
MOSTE	:	Ministry of Science, Technology and Environment
MPI	:	Ministry of Planning and Investment
NEA	:	National Environmental Agency
NIED	:	National Institute for Educational Development
PMB	:	Project Management Board
SC	:	Steering Committee
SCPE	:	Scientific Center for Population and Environment
TUPWS	:	Hanoi Transport and Urban Public Works Service
URENCO	:	Hanoi Urban Environment Company
VCCI	:	Vietnam Chamber of Commerce and Industry
VIWASE	:	Vietnam Consultant on Water Supply, Sanitation and Environment

International /Foreign Organizations

ADB	:	Asian Development Bank
ASEAN	:	Association of Southeast Asian Nations
CIDA	:	Canadian International Development Agency
EU	:	European Union
IBRD	:	International Bank for Reconstruction and Development (World Bank)
JICA	:	Japan International Cooperation Agency
JBIC		Japan Bank for International Cooperation
NGO	:	Non-Government Organization
OECD	:	Organization for Economic Cooperation and Development
SIDA	:	Swedish International Development Agency
The JICA Study Team	:	The JICA Team for the Study on Environmental Improvement for Hanoi City
UNDP	:	United Nations Development Program
UNICEF	:	United Nations International Children's Emergency Fund
UNIDO	:	United Nations Industrial Development Organization
WHO	:	World Health Organization

Others

BOD	:	Biochemical Oxygen Demand
C	:	Carbon
CECS	:	Center for Environmental Chemistry Studies
CEST	:	Center for Environmental Science and Technology
CH_4	:	Methane
CO_2	:	Carbon dioxide
COD	:	Chemical Oxygen Demand
CRES	:	Center for Regional and Environmental Studies
Cl	:	Chlorine
DID	:	Densely Inhabited District
DO	:	Dissolved Oxygen
EAR	:	Environmental Awareness-Raising
EARET	:	Environmental Awareness-Raising, Education and Training
EE	:	Environmental Education
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Master Plan
ES	:	Executive Seminars

F/S	:	Feasibility Study
GDP	:	Gross Domestic Product
GRP	:	Gross Regional Product
H	:	Hydrogen
IUPM	:	Industrial and Urban Pollution Management
LEP	:	Law on Environmental Protection
LM	:	Laboratory and Monitoring
MEIP	:	Metropolitan Environmental Improvement Program
M/P	:	Master Plan
N	:	Nitrogen
O	:	Oxygen
ODA	:	Official Development Assistance
O&M	:	Operation & Management
SEDS	:	National Socio-Economic Development Strategy
P	:	Phosphorous
PVC	:	Polyvinyl chloride
SS	:	Suspended Solid
STW	:	Sewage Treatment Works
SWM	:	Solid Waste Management
SWS	:	Solid Waste Services
SWTC	:	Solid Waste Treatment Complex
The JICA Study	:	The Study on Environmental Improvement for Hanoi City
T-N	:	Total Nitrogen
T-P	:	Total Phosphorous
TCVN	:	Vietnam Standard
TMS	:	Time and Motion Survey
TSP	:	Total Suspended Particulate
VAT	:	Vietnam-Australia Training Project
VCEP	:	Vietnam Canada Environment Project
WSP	:	Waste Stabilization Pond

UNITS OF MEASUREMENT

T/Y	:	Tons per year
US$	:	United States Dollar
VND	:	Vietnamese Dong
dB	:	Decibel(s)
g/d	:	Grams per day
ha	:	Hectare
km^2	:	Square kilo meter
m^2	:	Square meter
m^3	:	Cubic meter
m^3/d	:	Cubic meter per day
mg/l	:	Milligram per liter
t/m^3	:	Tons per cubic meter
wt%	:	Weight percent

Chapter 6 Measures and Projects for Effective Management and Improvement of Environment

6.1 Approach to the Effective Environmental Management and Improvement

In working out the strategies and measures/projects for environmental management and improvement, special attention has been paid to (i) Basic Governmental policy, (ii) Effectiveness and efficiency of the measures, and (iii) Avoiding as much as possible financial burden on the Government. More specifically, following approaches have been adopted.

- More emphasis on effectiveness and efficiency in environmental management rather than the scale of overall benefit.
- Realistic, implementable approach, in particular recommending measures within the capacity to pay/afford of the Government/HPC and people
- Staged development of counter-measures and projects both structural and non-structural ones, keeping step with the development of economy, affordability of the Government and people, Government reform, etc.
- Due consideration to the administrative reform policy of the Government, i.e., reduction of government staff, reduction of subsidy, etc. with exception of strategic organizations to cope with the increasing needs including the environmental management
- Stronger coordination among organizations
    - Stronger coordination, cooperation
    - Clearer demarcation of responsibilities among Departments and the Local and the Central
    - More appropriate share of responsibility, for example leave the solution of environmental disputes to District/Commune PCs
    - More smooth share/dissemination of information/data among the organizations concerned rather than just increase of number of staff
- More emphasis on legal/institutional/organizational measures relative to the structural measures which necessitate big capital outlay
- Adopting appropriate technologies, fit to the type of land use, population density, intensity of economic activities, etc., for example central sewerage for the central part of Hanoi, septic tanks for the sub-urban areas
- Incorporation of environmental consideration into upstream planning, in particular socio-economic planning and urban land use planning
- Where deemed appropriate and more efficient as well as reducing the financial burden of the Government, recommendation for the privatization of public bodies

6.2 Measures and Projects for Achieving a Sanitary Water Environment

6.2.1 Basic Concept for Plan Formulation

Improvement of the sanitary water environment in the urban area is necessary for the most urgent environmental needs, as described in Section 3.1 of Part 2. Main measures for achieving sanitary water environment are to establish and improve a comprehensive urban drainage system. In this study, the Drainage Master Plan, what was prepared by HPC in cooperation with JICA in 1995, was reviewed and adopted for formulating a plan of the urban drainage system. The drainage system includes flood control, drainage, a flood forecasting and warning system, a dyke system, and river/lake conservation.

The required urban drainage improvement consists of two major schemes, namely, flood control and drainage for the To Lich and Nhue River basins, which are separated by the natural levee along the To Lich River. The ongoing dyke-system protection project being carried out of MOARD includes dyke rehabilitation along the Red River, and a flood forecasting and warning system. River and lake conservation includes several schemes for water quality betterment and environmental improvement along rivers and surrounding lakes in the urban area.

(1) Planning Aspects

1) Target Year

The flood control and drainage improvement plan is formulated on the basis of the City Master Plan for the year 2020 that has been approved by the Government of Vietnam.

2) Project Area

The target area is the urban area with a total area of 255 km^2, as defined by environmental zoning. However, it is clear that Gia Lam and Dong Anh Urban Areas do not suffer from flood damage, and so in both these environmental zones drainage should be developed gradually in accordance with the City Master Plan.

The proposed project area is the only urban area between the Red River and the Nhue River, covering about 136 km^2, including seven urban districts of 84 km^2, and adjacent farmland of 52 km^2 in Tu Liem and Thanh Tri suburban districts. The area is divided by a natural watershed of levees along the right bank of the To Lich River into two basins: the To Lich River basin (78 km^2) including the West Lake subbasin (10 km^2) and the Nhue River basin (58 km^2).

3) Design Population

The population that will benefit directly from the project is assumed as shown below:

Beneficiary

	1997	2005	2010	2020
To Lich River Basin	1,069,000	1,024,200	984,900	1,003600
West Lake Subbasin	20,500	24,400	27,800	32,000
Nhue River Basin	521,500	552,600	579,800	668,000

4) Protection Levels

Protection levels of the urban drainage plan are set out below:

- The river/drainage channel system: a 10-year return period
- The sewer collection system: a 5-year return period
- The dyke protection of the Red River: more than a 100-year return period

5) Allowable Discharges to Nhue River

The design basis for the Nhue River Improvement to be conducted by MOARD are:

a) Protection Level:10-year (10%)

b) Design Discharges:Calculated at a specific discharge, 0.6 $m^3/s/km^2$

c) High Water Level (HWL): EL. MSL 5.8m at Hadong Weir

Natural drainage from the To Lich River basin to the Nhue River is possible for small-scale floods. The maximum discharge from the To Lich River to the Nhue River should, even in small-scale floods, be limited at 0.6 $m^3/s/km^2$ based upon the above design basis of the Nhue River. For the Nhue River basin, on the other hand, discharges must always be confined to less than 0.6 $m^3/s/km^2$, whether natural or mechanical drainage is applied. The following table shows the allowable discharges and the high water levels (HWL) of the Nhue River at the outlets of the relevant subbasins:

Allowable Discharges and HWL

Basin	Catchment Area (km^2)	Allowable Discharge (m^3/s)	HWL of the Nhue River at its Outlets EL. MSL (m)
To Lich	77.5	45	5.7
Co Nhue	19.7	12	6.0
My Dinh	13.6	8	5.9
Me Tri	14.7	9	5.8
Ba Xa	9.9	6	5.7

The improvement plan for flood control and drainage in the urban area should be formulated based on the above allowable discharges and HWL.

(2) Drainage Zoning

Drainage zoning should be determined based on the natural watersheds in order to minimize the environmental impact on ecosystems after completion of the project. The Study area is divided into the following drainage zones by the rivers, lakes, and watersheds:

- To Lich River Basin (comprising 7 basins): 77.5 km^2
- Nhue River Basin (comprising 4 basins): 57.9 km^2
- Nhue River Basin (rural area): 125.6 km^2
- Bac Hung Basin (Gia Lam): 95.1 km^2
- Duong Basin (Dong Anh): 186.7 km^2
- Ca Lo-Cau Basin: 364.2 km^2

(3) Drainage Method and Directions

In the To Lich River basin, it is nearly impossible to drain out the design flood using gravity to the Nhue River. This is easily proved by the following facts. The high water stage of over EL.5m lasted 5 to 20 days along the Nhue River in the 1978, 1984, and 1989 floods, hence the design high water level has been set approximately at EL.5.8 m in the stretches.

To prevent serious inundation in the urban area, the water levels of the To Lich River basin should be confined to less than EL. 3.5m, as previous studies stated. In applying mechanical drainage for the To Lich River basin, the cost-effective direction of the drainage is towards the Red River from the Yen So site. Furthermore, to unload the capacity of the pumps economically, construction of regulating reservoirs near the pumping station should be taken into account.

On the other hand, both mechanical and natural drainage methods are examined for the Nhue River basin (comprising four subbasins) where the ground elevations (EL.

4.5 to 9.5m) are lower than the high water level of the Nhue River (EL.5.8m approximately). Mechanical drainage should be supported by the construction of regulating reservoirs for the same reason as above. The direction of the drainage must be limited by topography, towards the Nhue River.

The following drainage methods and direction are proposed for improvement of flood control and urban drainage.

Drainage Methods & Directions

River Basin	Present Land Use	Drainage Method	Direction of Drainage
To Lich	Urban	Mechanical drainage combined with regulating reservoirs	To Red River from Yen So site
Nhue	Suburban	Mechanical drainage combined with regulating reservoirs, or natural drainage combined with the same, accompanied by land reclamation works	To Nhue River from the outlets of respective drainage sub-basins

(4) Plan for River/Drainage Channel System in the To Lich River Basin

1) Treatment of West Lake

Drainage of the To Lich River basin will be achieved primarily by a combination of pump facilities and regulating reservoirs at the Yen So site. However, it is economically essential to limit as much as possible the floodwater flowing down to Yen So from the upper reaches. On the other hand, there are many lakes and ponds in the basin, the most substantial being West Lake (5.2 km^2).

In this case, when providing gate structures at the outlets of the lake to maintain the normal water level at EL. MSL 6.0 m, all the floodwater from the catchment (9.3 km^2) can be contained under the high water level of EL. MSL 6.5 m without affecting the shore areas. As a matter of course, after the flood, the gates are opened and the water level of the lake returns to normal. These gate structures will entail a minimal cost, but will contribute significantly to the reduction of flood discharge at the Yen So site.

2) Diversion of Upper Lu and Hoang Liet Basins

A bridge is constructed along the National Road Route No.1 spanning the Kim Nguu River. The bridge may not be large enough to pass all the floodwaters from the To Lich, Lu, and Hoang Liet basins towards the Yen So site. To cope with this restriction, the following two diversion plans are conceived:

a) Diversion of the Upper Lu River basin to the Set River using the existing Lu floodway to the maximum extent of flow capacity of another bridge on National Road Route No.1 across the floodway; and

b) Diversion of the Hoang Liet drainage basin to the Set River by expanding an existing box culvert under National Road Route No.1.

3) Normal and High Water Levels

The normal water level in the To Lich River system has been set up at EL. MSL 3.5m under an agreement among the agencies concerned. This water level results from coordinating the multipurpose use of the rivers including flood control and water supply for agricultural lands and fishponds. This agreement will still be valid in this plan, since lowering the water level below EL. MSL 3.5m must bring about an excessive draw-down of water levels in the upper channels that is not recommended from an environmental point of view.

On the other hand, the design high water level is generally recommended not to exceed the ground elevations on both sides, to ensure easy drainage from the basin. Hence, the design high water levels of the To Lich River system were established starting from EL. MSL 3.5m (same as the normal water level) at the Yen So site, with the following longitudinal gradients:

- To Lich River :1/7,000 (1/15,000)
- Lower Lu River :1/8,000
- Set River :1/3,000
- Lu Floodway and Upper Lu River :1/4,500
- Kim Nguu River :1/1,500

(5) Plan for Drainage Channel Systems in the Nhue River Basin

1) High Water Levels

High water levels (HWL) at the outlets of the drainage channel systems in the Nhue River basin are determined by the ground elevations when applying mechanical drainage, while they are determined by the high water levels of the Nhue River when applying natural drainage, as follows:

Title

Drainage Basin	HWL at Outlet: EL. MSL (m)	
	Mechanical Drainage	Natural Drainage
Co Nhue	5.2	6.0
My Dinh	4.7	5.9
Me Tri	4.7	5.8
Ba Xa	4.5	5.7

Note: Longitudinal gradients of the drainage channels are commonly 1 / 5,000 in accordance with the average ground slope.

2) Design Parameters for Pumping Stations and Regulating Reservoirs

(a) Locations

A pumping station and a regulating reservoir are constructed at the outlet of each drainage system.

(b) Pump Capacities

The capacities of the pumping stations, if required, should be the same as the aforesaid allowable discharges tabulated respectively.

(c) Dimensions of Regulating Reservoirs

Floodwaters exceeding the allowable discharge of each drainage system will be contained in the regulating reservoir, either applying mechanical or natural drainage methods. The normal water depth and the effective water depth for flood storage are 1.0 m and 4.0 m, respectively.

(6) Plan for Sewer Systems

1) Design Storm water Flow

The design storm water flow should be calculated by using the rational formula and the rainfall intensity formula worked out by the Ministry of Construction in Vietnam as shown below:

Q= (1/360)CqA, q = [5416 (1 + 0.25 x log P x t^0.13)]/ (t + 19)^0.82

Where,

Q :Design storm water flow (m^3/s)
C :Runoff coefficient
A :Drainage area (ha)
q :Rainfall intensity (l/sec/ha, or mm/ha if divided by 0.36)
P :Return period
t :Concentration time (min.)

The runoff coefficient should be the overall runoff coefficient of each river basin calculated by runoff coefficients at each area with individual surface characteristics.

2) Design Policy

The design policy of the sewerage system within the study area has been decided as follows:

(a) To apply the regulations and standards adopted in Vietnam and Japan

(b) To preserve the existing drainage basins.

(c) To adopt the combined system in the present urban area with the existing combined system, and a separate system in the other areas.

(d) To take adequate counter-measures against flooding according to the local conditions.

3) Design Criteria for the Drainage System

(a) Design Flow

Sewerage facilities, including sewers, should be, in principle, based on the design flow as follows:

Design Flow of Sewerage Facilities

Collection System	Facilities	Design Flow
Separate System	Sewer	DSF
	Pumping Station	DSF
Combined System	Combined Sewer	HMWF+DSF
	Pumping Station	
	- Combined Sewage	HMWF+DSF
	- Storm-water	> DSF-2· HMWF

Note: 1) HMWF: Hourly Maximum Wastewater Flow
2) DSF: Design Storm-water Flow

(b) Hydraulic Design for Sewers

The hydraulic design of the sewers is based on Manning's formula.

(c) Roughness Coefficient

Reinforced concrete pipes will be used for the sewers. The roughness coefficient of the concrete pipe is taken at 0.013, taking into account that this is a long-term operation.

(d) Allowable Flow Velocity

The minimum velocity should not be less than 0.8 m/sec for the combined storm-water sewer in order to avoid sedimentation and to keep as much consistency with the on-site road gradient as possible. Maximum velocity should be limited to 3.0 m/sec in order to prevent pipes from eroding.

(e) Allowance of Sewer Capacity

The allowance of the combined storm water sewer capacity will be 10% to 20% of the design flow. The allowance is generally applied to select sewer pipes in consideration of unexpected flow fluctuations and prevention against the putrefaction of sewage. The minimum size of pipe to be selected will be 250 mm for the combined storm water sewer to facilitate maintenance and operation.

(f) Depth of Earth Covering

The minimum earth covering is determined at 1.0 m to prevent any collapse of the pipes. The maximum depth of earth covering is determined to be 7.0 m in order to minimize construction cost.

(g) Maximum Manhole Interval

Manholes should be located where changes in flow direction, pipe gradient and diameter occur, and the originating point of the sewer pipeline and the junction of the pipes. The maximum manhole interval for each size of sewer is proposed as 50 m for 300 mm, 75 m for less than 600 mm, 100 m for less than 1,000 mm, 150 m for less than 1,500 mm and 200 m for more than 1,500 mm.

(h) Connection of Pipes

A pipe bottom connection is recommended in view of the depth of the pipe laying and construction cost. The hydraulic gradient along the sewer pipeline should be kept below the ground surface.

4) Development plan for storm water collection sewers

The layout plan of the urban drainage development system is shown in Figure 6.2.1. The proposed development plan of the study area is composed of:

(a) Improvement works for existing pipes of the combined system, with a total length of 14 km, plus manholes;

(b) Installation works for new pipes in the To Lich River basin consisting of four sub-basins, To Lich, Lu, Kim Nguu, and Set, with a total length of 336 km;

(c) Installation works for new pipes in the To Lich River basin consisting of two sub-basins, Hoan Liet, and Yen So with a total length of 136 km;

(d) Installation works for new pipes in the West Lake subbasin with a total length of 41 km;

(e) Installation works for new pipes in the Nhue River basin consisting of four subbasins, Co Nhue, My Dinh, Me Tri, and Ba Xa, with a total length of 579 km; and

(f) Installation works for new street drains along the new road network, prepared by UPI, with a total length of 1,051 km.

(7) Plan for Interface between Drainage Channels and Sewers

In the Master Plan, it is proposed that sewer systems will cover the areas where catchments are smaller than 1km^2, and drainage channels will be improved, or newly constructed to receive all the discharge from the sewer systems. Sewers will be constructed beneath main roads. This criterion is based on economic considerations, even taking into account the difficulty of land acquisition due to open channel construction in small areas. Delineated in Figure 6.2.2 are the drainage channels to be provided in the project. The channel density is about 1 km/1km^2 almost for the whole study area.

(8) Overall plan for urban drainage

The overall improvement plan for drainage in the urban area is shown in Figure 6.2.2. Given that the fundamental planning involves river/drainage channel systems in the To Lich and Nhue River basins, and a sewer system in both basins, there are generally two ways to reduce flood damage:

1) Structural Measures

- River/drainage channel improvement;
- Provision of pumping stations;
- Construction of regulating reservoirs;
- Installation of floodgates; and so on.

2) Non-structural Measures

- Land use control;
- Flood forecasting and warning;

- Evacuation of residents; and so on.

However, the seriousness of flooding and the size of flood damage in the urban area consisting of three environmental zones demonstrate the need to emphasize structural measures that could bring about more fundamental and urgent solutions to this area. Hence, the improvement plan for the urban drainage system deals mainly with structural measures as described in Subsection 6.2.3, although some non-structural measures are discussed in Subsection 6.2.2.

(9) Further study required to parallel urban drainage improvement

The urban drainage improvement plan is formulated on the assumption that Nhue River is improved with a 10-year return period protection level and is secured with the specific discharge of 0.6 $m^3/s/km^2$ by MOARD.

It is highly recommended that to ensure the effectiveness of the drainage improvement plan in the urban area, the Nhue River improvement plan over its whole stretches be further examined and implemented by MOARD as soon as possible. The river improvement work is foreseen to require many years and involve huge costs. It would be most important to use a cost-effectiveness approach, such as a reduced protection level for the initial stage, polder dike protection for selected areas, use of low-lying areas as temporary retarding basins (including paddy field), etc.

6.2.2 Institutional and Regulatory Measures

(1) Setting Appropriate Standards for the Drainage System

Protection levels in the urban drainage plan have been set at a 10-year return period (10%) for the river/drainage channel system, and at a 5-year return period (20%) for the sewer collection system. The protection level for the Red River dyke rehabilitation is more than a 100-year return period (less than 1%). This is because:

1) The Nhue River improvement project and the projects of the Yen So pumping station and regulating reservoir have been established by MOARD at a 10-year return period protection level; and

2) The proposed protection levels can be compared to those adopted in drainage projects for other South East Asian capitals: 5- to 10-year in Manila, 2- to 15-year in Jakarta, and 10-year in Vientiane.

3) A 5-year return period for sewer collection is usually adopted in developed countries. In case of storm water with more than a 5-year return period, a

paved road is able to function temporarily as the main drain instead of a sewer.

4) The Red River, which originates in China, is the largest river system in the north of the country, and the second largest in Vietnam. MORD has set the protection level at more than a 100-year return period for the Red River.

(2) Reinforcement of Regulations, Monitoring and Law Enforcement

1) Overall management of lakes and ponds (by 2005)

Regarding flood control and drainage, HSDC should reserve the right of overall management of these lakes and ponds in the urban area since currently almost all the lakes and ponds are under the control of several authorities, such as MOARD, local communities and fishing companies due to the multipurpose use of these water bodies.

2) Land use control (from 2000 up to 2020)

New planning and substantial changes to the existing land use should be referred to HSDC prior to the approval of higher authorities under the close coordination of HUPI and HSDC. This is because changes in land use in the catchment area greatly influence flood control and drainage works.

3) Illegal dumping of solid waste (urgent)

Solid waste dumping into the rivers, lakes and ponds has caused rapid deterioration of their flood control and drainage functions, and the aesthetics of the areas concerned Counter-measures need to be worked out under the cooperation of URENCO and HSDC.

4) Construction and reconstruction of bridges and roads (urgent)

Construction and reconstruction of bridges, roads, and utility lines intersecting the controlled areas of HSDC should be subject to the approval of the same. In this procedure, HSDC should assess whether or not these structures may damage the flood control and drainage functions of the stretch or area in question.

5) Flood control and information systems in the whole city (2005)

Floodwater and wastewater from the Hanoi area (under the management of HSDC) discharges into the Red River and Nhue River which are managed by MOARD. Both agencies are recommended to establish a coordinating body for the preparation of technical agreements concerning:

- Operation and management of the pumping stations and floodgates;
- Flood fighting activities;

- Flood forecasting and warning system; and
- Exchange of data and information.

(3) Organizational Strengthening: HSDC (drainage function)

Organizational strengthening discussed in this section of the report deals with needs related to operation and maintenance of the drainage system and management in general. The word "strengthening" means making improvements to management systems, and organizational structure that are required to meet new functions that HSDC will be required to carry out. The ultimate goal is to ensure that organizational strengthening will lead to a reduction in flooding and the cost-effective and responsive delivery of public services. The improvement strategy is based on achieving the following objectives:

- develop a functional organizational structure that improves maintenance and reduces the impact of operations on the public
- make human resources development a priority. Include sufficient funding in the annual operating budget for training and the purchase of software, hardware, equipment and tools to support enhanced personnel skills.
- improve maintenance levels to protect the significant investment in infrastructure and reduce the risk of flooding
- Depreciate & replace fixed assets based on economic life-cycle, using internal funding to reduce dependence on transfers from HPC.
- Strengthen technical capacity of in-house personnel to support operation of flood control systems and implement maintenance management systems.

The framework for organizational strengthening is summarized in the following table:

HSDC Organisational Strengthening Framework for Drainage

OBJECTIVE	SHORT TERM 2005	MID TERM 2010	LONG TERM 2020
Re-organize to suit new operational functions	Drainage Functions: - Create new organizational unit for drainage operations - Increase personnel assigned to maintenance of levees - Implement a team of mechanics and electricians dedicated to maintenance of Yen So pumping station	Sewerage Functions: - Create new operational units for each new wastewater treatment plant Sewerage and Drainage Functions: - Create a new sewerage and drainage enterprise for Gia Lam urban district.	Sewerage and Drainage Functions: - Create separate operational divisions for sewerage and drainage functions. - Create a new technical services division to provide engineering, maintenance and construction support to sewerage and drainage operating divisions
Develop human resources	Drainage Functions: - hire personnel for operation of Yen So pumping station and control gates - include funds for staff training in the annual operating budget Management Functions: - provide training and develop skills for business accounting, financial analysis and economic effectiveness of business operation.	Drainage Functions: - provide computers and software tools to engineering department for flood database and mapping project Management Functions: - provide training on pricing strategies and tariff setting for cost recovery	Drainage Functions: - develop software and hardware tools to support engineering analysis and modeling for flood control operations - develop technical skills required to support drainage system operators
Improve financial management	Sewerage and Drainage Functions: - work with the Water Supply Business company to improve billing and collection of sewer revenues - Implement a cost accounting system and develop trends for major cost centers.	Sewerage and Drainage Functions: - implement progressive tariff increases within the limits of affordability to recover the costs of operating new wastewater treatment plants - prepare multi-year operating budget forecasts linked to investment program planning	Sewerage and Drainage Functions: - replace assets based on economic life-cycle cost analysis - identify cost reduction opportunities using the cost-accounting system.

OBJECTIVE	SHORT TERM 2005	MID TERM 2010	LONG TERM 2020
Implement maintenance management systems	<u>Sewerage and Drainage Functions</u>: - integrate mechanical and electrical maintenance enterprises to provide centralized support to operating enterprises - responsibility for preventive maintenance is shifted to trades located within each operating group	<u>Sewerage and Drainage Functions</u>: - implement a work order system for scheduling of all preventive and emergency maintenance - develop a sewer inventory	<u>Sewerage and Drainage Functions</u>: - develop advanced preventive maintenance technologies
Provide technical support to operations	<u>Sewerage Functions:</u> - implement a central laboratory to support treatment plant process control and operations - Implement an approvals and inspection unit for community and on-site wastewater disposal systems.	<u>Drainage Functions</u>: - implement a task group within engineering department to develop flood database and maps	<u>Drainage Functions</u>: - develop models to assist operators in optimizing water levels and control flooding - Create a new technical services division to provide engineering support to operating groups

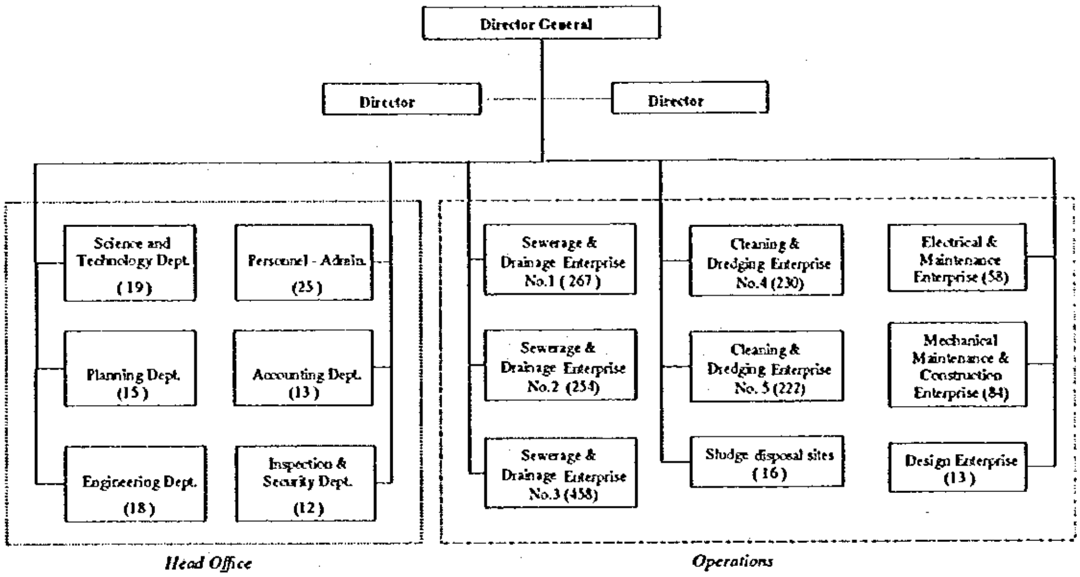
Components of the strategy are organized into a framework showing approximate timeframes for implementation and which area of the organization will be affected. Specific recommendations for improvement are discussed in the following sections.

1) Short – term measures: 2005

HSDC carries out a number of O&M tasks related to drainage:

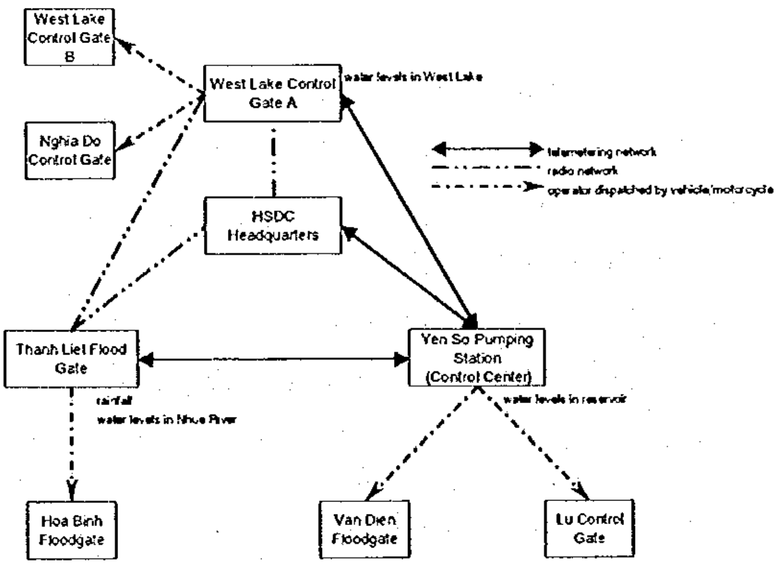
- Dredge canals and lakes
- Maintain levees
- Operate flood control gates
- Monitor water levels for operational control

The existing organization, presented below, is well structured and equipped to cope with the maintenance of canals and lakes but not organized for operation of flood control infrastructure.



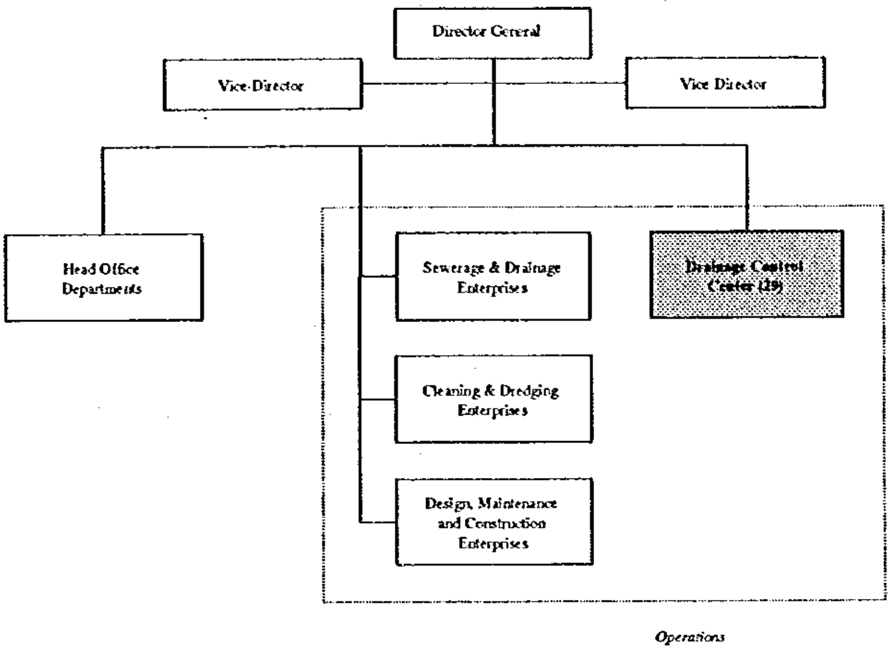
Existing Organization Structure
(brackets indicate number of staff)

Some organizational changes will be required to operate the new reservoir and storm water pumping station being constructed at Yen So as part of a flood control scheme for the To Lich River. The control scheme, shown below, will require good coordination and communication as well as a high level of operator competence to ensure the infrastructure performs as intended.



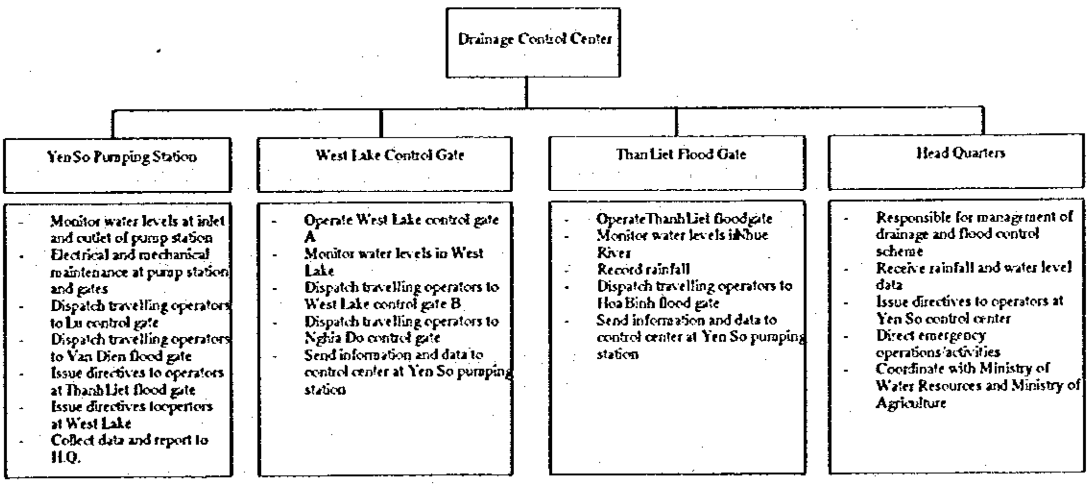
Drainage Control Scheme

The drainage project will create the need for technically competent operators and maintenance staff with specialized skills to maintain pumps, control systems, and telemetering systems. Responsibility for operation of the pumping station, flood and control gates should be given to a group of specially trained operators within a newly created Drainage Control Center shown in the simplified organization chart below.



Proposed Organization Structure: 2005 (simplified)

The functional organization structure for the proposed Drainage Control Center, including maintenance crews is shown below.



Functional Organisation for Drainage Operation Center: 2005

The new flood control system will integrate the operation of Yen So pumping station with a number of flood and control gates located area wide. Data on rainfall and water levels will be collected at Thanh Liet flood gate and West Lake control gate (A). Data will transmitted by telemetry to a control center at Yen So where operators will decide on the opening and closing of control and flood gates. Some gates will be operated manually by travelling operators. Other gates will be operated by telemetry from the Yen So pumping Station.

Equipment and tools for cleaning drainage canals has recently been provided under the drainage improvement project funded by OECF. More personnel will be required to maintain the large number of levees recently rehabilitated throughout the city and levees newly constructed under the drainage project. It is proposed that each sewerage and drainage enterprise dedicate more work crews to the task of maintaining levees.

Maintenance of the pumping station equipment and gates can be carried out by existing electrical and mechanical maintenance enterprises without the need to increase the number of maintenance personnel. Staff will, however, need training for specialized maintenance of pumps and check valves.

The flood control gates and pumping station need to be properly maintained for reliable operation. Therefore it is recommended that maintenance personnel be seconded from the central maintenance enterprises and be dedicated solely to maintenance of pumping station and gates. Furthermore, maintenance crews should be stationed at Yen So to reduce travel time, improve emergency response and facilitate familiarization with specialized equipment.

Travelling operators will need vehicles to reach remote flood control gates and water level monitoring stations.

2) Mid-term:2010

Once the organization becomes comfortable with the operation of Yen So reservoir and the flood control scheme, it will need to develop the database required to support operational control decisions and operational policies regarding flood control and water levels. Two new tasks will be required:

- Compile data on flooding and flood damages
- Prepare flood mapping

It is proposed that the engineering division implement these tasks. Data on rainfall and water levels will be collected by operators at Yen So and sent to the Engineering Division for analysis and database entry. Data on flood damage will be correlated to data on water levels. These tasks should form part of an ongoing program of data collection, analysis, and reporting. A number of engineers and technicians will be required on a full time basis to develop the database, interpret the data, and develop computer based flood maps. Computers and software tools will be required to support the development of the database and computer based maps.

3) Longterm: 2020

The organization will have progressed by this stage and developed in-house technical expertise in the area of hydrology, open channel hydraulics, flood routing and reservoir control. The level of technological sophistication for operational control can be increased to include:

- modeling of reservoirs to optimize flood and control gate operations
- flood forecasting linked to water level monitoring and mapping tools

The engineering department will need to be strengthened by hiring qualified and specialized engineers capable of understanding and using models for analysis. The engineering department will need to increase computers and software tools to develop databases, models, and maps.

4) Staffing, equipment and financial implications of proposed reforms

Staffing requirements are developed as part of Human Resources in Chapter 6.11.3. Incremental staffing levels, investment and operating costs for the proposed reforms are presented for each year in Table 6.2.1. Annual program costs are summarized as follows:

Staffing Requirement

DIVISION/ PROGRAM	NO. OF STAFF (end of period)		
	2000-2005	2006-2010	2011- 2020
Flood control/drainage operations	29	29	29
Levee maintenance	63	63	63
Flood data, mapping and modeling	0	31	33
Total Investment costs (000's USD)	750	1060	1400
Annual Operating costs (000's USD)	277	299	300
HRD training investment cost (000's USD)	250*	205*	10 **

* indicates total investment cost for the period, provided as technical assistance through ODA

** indicates average annual cost, transferred to HSDC operating budget

Investment costs represent the sum of all capital costs for the period including equipment replacement. Annual operating costs are for the last year of the period indicated.

6.2.3 Improvement of the Storm water Drainage System

The improvement plan for the storm water drainage system in the urban area is proposed as shown in Figure 6.2.2 and the total construction cost of the flood control and drainage projects is estimated at US$ 346 million as shown in Table 6.2.1.

The drainage projects, including city river improvement works, will obviously require many years for implementation and will cost a lot as shown in Table 6.2.2. It is recommended that the projects be phased from technical, social, environmental, financial, and economic points of view. It is also proposed to adopt the most practical way to use a cost-minimizing approach, such as a reduced protection level for the initial stage, lake and pond dredging and conservation for use as retarding basins, and cleaning and rehabilitation of existing sewers.

The implementation schedule for the flood control and drainage projects is proposed as shown in Figure 6.2.3 and the proposed projects in each year are described below according to each target year for environmental improvement:

(1) Short-term measures: by 2005

1) Priority project: To Lich River basin drainage project

The To Lich River basin drainage project covering the Old City Center and Red River Right Bank-South environmental zones, which suffer seriously from flooding, is the most urgent project, with the number of beneficiaries estimated at more than one million.

The project is divided into two stages: the 1st Stage project for coping with a 5-year return period and the 2nd Stage project with a 10-year return period. The 1st Stage project has already commenced with the assistance of Japanese ODA as mentioned in Section 3.1 of Part 2. In order to achieve the targeted sanitary water-related environment, the following measures of the 2nd Stage project are necessary, and this project is selected as the top priority project among drainage projects proposed in this Study:

Outline of The 2nd Stage Drainage Project

Project Components	Second Stage
1) Yen So Pumping Station : augment of capacity	45 m^3/s
2) Regulating Reservoir (augment of volume) Linh Dam & Dinh Cong Lakes	1.32 million m^3
3) Drainage Channel Enlargement	31 km
4) Bridges/Box Culverts	29 places
5) City Lake Improvement - Dredging - Lakeshore Protection Works	 14 lakes 11 lakes
6) Installation of New Storm-water Sewers Rehabilitation of Existing Sewers	182 km 17 km

2) Other short-term measures

The following structural and non-structural measures are recommended to be carried out at the same time as the priority project with a view to enhancing the effectiveness of the priority project.

(a) Dredging and cleaning of existing sewers/channels: This work is carried out routinely by HSDC in order to increase the drainage capacity and reduce the frequency of inland flooding.

(b) Protection of the Hanoi dyke system (under execution by MOARD): The protection of dykes contributes significantly to the urban drainage projects with the objective of discharging inland water to the Red River.

(c) Land use control (flood plain management) by HPC as a non-structural flood mitigation measure, comprising zoning control and building and development control: The definite measures are i) Control of Reclamation Height, ii) Provision of Access Roads, iii) Flood Proofing of Buildings, iv) Conservation of Rivers and Lakes, and v) Preservation of Paddy Fields and Fishponds.

(d) Provision of on-site storage for new estate development: This is to compensate for the decrease in flood retardation of the original land due to urbanization and is comprised of i) Permeable pavements, ii) Infiltration trenches, wells, and gutters, iii) Storage ponds for the development area, iv) Ponding in a athletic fields or parking lots, vi) Roof storage and rainwater tanks in individual houses.

(e) Flood forecasting and warning to be linked with a telemeter system by MOARD and HSDC.

(f) Public information and education with respect to flood control and drainage comprised of i) Preparation of a flood risk map showing the expected inundation depths for certain flood magnitudes, ii) A campaign to promote awareness among the people of the importance of the flood control and drainage projects.

Additionally, a drainage system at the eastern part of the Dong Anh Urban Area environmental zone will be developed by the Thang Long North-Van Tri Infrastructure Development Project under the OECF soft loan program.

(2) Medium-term measures: 2010

The northern part of the Red River Right Bank North West environmental zone is becoming rapidly urbanized and population is increasing as shown in Table 6.2.2. According to the 2020 City Master Plan, this zone aims to be an international city with large areas devoted to industrial estates, trading activities, international markets, and housing estates. The Co Nhue basin and My structural measures Dinh basin drainage projects should be implemented by 2010 with the following structural measures:

Structural Measures

Main Works	Co Nhue Drainage Basin	My Dinh Drainage Basin
1. Pumping Stations (m^3/s)	12	8
2. Regulating Reservoirs (1,000 m^3) Reservoir Are (ha) Spillway (m)	3,020 76 55	1,590 40 26
3. Drainage Channel Improvement (m) Bridges/culverts (place)	19,200 30	13,400 24
4. Sewer Construction (Area: ha)	1,970	670

Note: 1)Normal water depth 1.0m
2)Flood control depth 4.0m

(3) Long-term measures: by 2020

In order to improve the drainage system of the whole urban area, the following Me Tri basin and Ba Xa basin drainage projects will be implemented by 2020:

Structural Measures

Main Works	Me Tri Drainage Basin	Ba Xa Drainage Basin
1. Pumping Stations (m^3/s)	9	6
2. Regulating Reservoirs (1,000 m^3) Reservoir Are (ha) Spillway (m)	1,600 40 31	1,070 27 14
3. Drainage Channel Improvement (m) Bridges/culverts (place)	13,500 22	8,700 16
4. Sewer Construction (Area: ha)	870	440

Note: 1)Normal water depth 1.0m
2)Flood control depth 4.0m

(4) Project cost estimate and implementation schedule

The cost of the flood control and drainage project in the urban area is estimated as shown in Table 6.2.2 using the following assumptions for cost estimation:

(a) Adoption of unit prices in Vietnam at a 1999 base level

(b) Engineering Services Cost: About 15% of construction cost

(c) Administration Cost: 3% of construction cost

(d) Physical Contingency: About 10% of the cost for construction, land acquisition, engineering services, and administration

Table 6.2.2 also indicates the disbursement schedule for each drainage project according to the recommended implementation schedule as shown in Figure 6.2.3.

Costs of the urban drainage project and annual O&M cost for each drainage basin are summarized below:

Costs of Each Drainage Basin

(Unit: US$1,000)

Drainage Project	Project Cost	Annual O&M Cost	Implementation
1) To Lich Drainage Basin	317,818	1,437	1997 – 2006
(1st stage)	163,876	859	1997 – 2002
(2nd stage)	153,942	578	2002 – 2006
2) Co Nhue Drainage Basin	87,040	273	2004 – 2009
3) My Dinh Drainage Basin	41,350	159	2006 – 2010
4) Me Tri Drainage Basin	54,050	180	2006 – 2011
5) Ba Xa Drainage Basin	26,221	117	2010 – 2015
Total	526,479	2,166	

Table 6.2.1 Construction Cost, O&M and Replacement Costs for Drainage Project

Item	Area (km2)	Population (Beneficiaries) 1997	2005	2010	2020	Construction Cost ($1,000)	Annual O/M Cost: Rate for Construction Cost	Annual O/M Cost: Amount ($1,000)	Replacement Cost: Amount ($1,000)	Replacement Cost: Economic Life
A. TO LICH RIVER BASIN	68.2	1,069,049	1,024,193	984,943	1,003,644	214,996		1,437	48,763	
1. 1st Stage Project		534,525	512,097	492,472	501,822	113,388		859	32,477	
(1) Civil Works						80,911	0.3%	243	-	
(2) Pumps & Equipment						29,170	2.0%	583	29,170	25-year
(3) Gates						3,307	1.0%	33	3,307	25-year
2. 2nd Stage Project		534,525	512,097	492,472	501,822	101,608		578	16,286	
(1) Civil Works						85,323	0.3%	256	-	
(2) Pumps						15,970	2.0%	319	15,971	25-year
(3) Gates						315	1.0%	3	315	25-year
B. NHUE RIVER BASIN	57.9	521,487	552,571	579,770	668,000	130,757		729	20,446	
1. Co Nhue Basin	19.7	177,432	188,008	197,262	227,282	54,787		273	6,660	
(1) Civil Works						48,127	0.3%	144	-	
(2) Pumps						6,210	2.0%	124	6,210	25-year
(3) Gates						450	1.0%	5	450	25-year
2. My Dinh Basin	13.6	122,491	129,792	136,181	156,905	26,659		159	4,776	
(1) Civil Works						21,883	0.3%	66	-	
(2) Pumps						4,536	2.0%	91	4,536	25-year
(3) Gates						240	1.0%	2	240	25-year
3. Me Tri Basin	14.7	132,398	140,290	147,195	169,596	30,801		180	5,252	
(1) Civil Works						25,549	0.3%	77	-	
(2) Pumps						4,982	2.0%	100	4,982	25-year
(3) Gates						270	1.0%	3	270	25-year
4. Ba Xa Basin	9.9	89,166	94,481	99,132	114,218	18,510		117	3,758	
(1) Civil Works						14,752	0.3%	44	-	
(2) Pumps						3,618	2.0%	72	3,618	25-year
(3) Gates						140	1.0%	1	140	25-year
Total	126.1	1,590,536	1,576,764	1,564,713	1,671,644	345,753	-	2,166	69,209	-

Table 6.2.2 DISBURSEMENT SCHEDULE FOR DRAINAGE MASTER PLAN (1/6)

Unit : US$1,000

Item	Total	Year												
		1997	1998	1999	2000	2001	20002	2003	2004	2005	2006	2007	2008	2009
I. TO LICH RIVER BASIN														
1st Stage Project														
1) Construction Cost	113,387	72	18,095	30,729	39,026	22,577	2,888							
a. Site Preparatory Works	722	72	578	72										
b. Main Civil Works	85,068		8,507	28,622	31,524	15,153	1,262							
c. Drainage Channel Imp.	4,548			455	1,819	1,819	455							
d. Lake Improvement	3,367			337	1,430	1,432	168							
e. Sewer Reh. & Const.	10,032			1,003	4,013	4,013	1,003							
f. Supply of Equipment	9,650		9,010	240	240	160								
2) Administration Cost	3,402	340	510	851	851	510	340							
3) Land Acquisition and Compensation Cost	15,181	2,396	6,666	4,925	1,194									
4) Engineering Service Cost	17,008	2,430	4,859	4,859	2,430	1,620	810							
5) Sub-total	148,978	5,238	30,130	41,364	43,501	24,707	4,038							
6) Physical Contingency	14,898	524	3,013	4,136	4,350	2,471	404							
Total	163,876	5,762	33,143	45,500	47,851	27,178	4,442							

Table 6.2.2 DISBURSEMENT SCHEDULE FOR DRAINAGE MASTER PLAN (2/6)

Unit : US$1,000

Item	Total	Year												
		1997	1998	1999	2000	2001	20002	2003	2004	2005	2006	2007	2008	2009
I. TO LICH RIVER BASIN														
2nd Stage Project														
1) Construction Cost	101,608							10,009	37,934	38,160	15,505			
a. Main Civil Works	27,878							3,395	16,573	7,910				
b. Drainage Channel Imp.	17,723							1,772	5,317	7,089	3,545			
c. Lake Improvement	7,584								1,517	3,792	2,275			
d. Sewer Reh. & Const.	48,423							4,842	14,527	19,369	9,685			
2) Administration Cost	3,048						305	610	914	914	305			
3) Land Acquisition and Compensation Cost	20,050						4,010	8,020	8,020					
4) Engineering Service Cost	15,241						6,096	3,048	3,048	1,524	1,524			
5) Sub-total	139,947						10,411	21,687	49,916	40,598	17,334			
6) Physical Contingency	13,995						1,041	2,169	4,992	4,060	1,733			
Total	153,942						11,452	23,856	54,908	44,658	19,067			

Table 6.2.2 DISBURSEMENT SCHEDULE FOR DRAINAGE MASTER PLAN (3/6)

Unit : US$1,000

Item	Total	Year												
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
II. NHUE RIVER BASIN														
Co Nhue Basin														
1) Construction Cost	54,787			15,246	16,607	17,171	5,763							
a. Drainage Improvement	25,801			7,740	7,740	7,740	2,581							
b. Nhue River Left Levee	565					565								
c. Sewer Construction	25,019			7,506	7,506	7,505	2,502							
d. River/Lake Conservation	3,402				1,361	1,361	680							
2) Administration Cost	1,644	247	247	329	329	328	164							
3) Land Acquisition and Compensation Cost	14,478	4,343	4,343	2,896	2,896									
4) Engineering Service Cost	8,218	1,644	822	1,644	1,644	1,644	822							
5) Sub-total	79,127	6,234	5,412	20,115	21,476	19,143	6,749							
6) Physical Contingency	7,913	623	541	2,011	2,148	1,914	675							
Total	87,040	6,857	5,953	22,126	23,623	21,057	7,424							

Table 6.2.2 DISBURSEMENT SCHEDULE FOR DRAINAGE MASTER PLAN (4/6)

Unit : US$1,000

Item	Total	Year												
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
II. NHUE RIVER BASIN														
<u>My Dinh Basin</u>														
1) Construction Cost	26,659						5,991	6,695	7,278	6,695				
a. Drainage Improvement	15,516						3,879	3,879	3,879	3,879				
b. Nhue River Left Levee	348								348					
c. Sewer Construction	8,446						2,112	2,111	2,112	2,111				
d. River/Lake Conservation	2,349							705	939	705				
2) Administration Cost	800				160	120	160	120	120	120				
3) Land Acquisition and Compensation Cost	6,133				1,840	1,840	1,227	1,226						
4) Engineering Service Cost	3,999				1,600	400	800	800	800	400				
5) Sub-total	37,591				3,600	2,360	8,178	8,841	8,198	7,215				
6) Physical Contingency	3,759				360	236	818	884	820	722				
Total	41,350				3,960	2,596	8,996	9,725	9,018	7,937				

Table 6.2.2 DISBURSEMENT SCHEDULE FOR DRAINAGE MASTER PLAN (5/6)

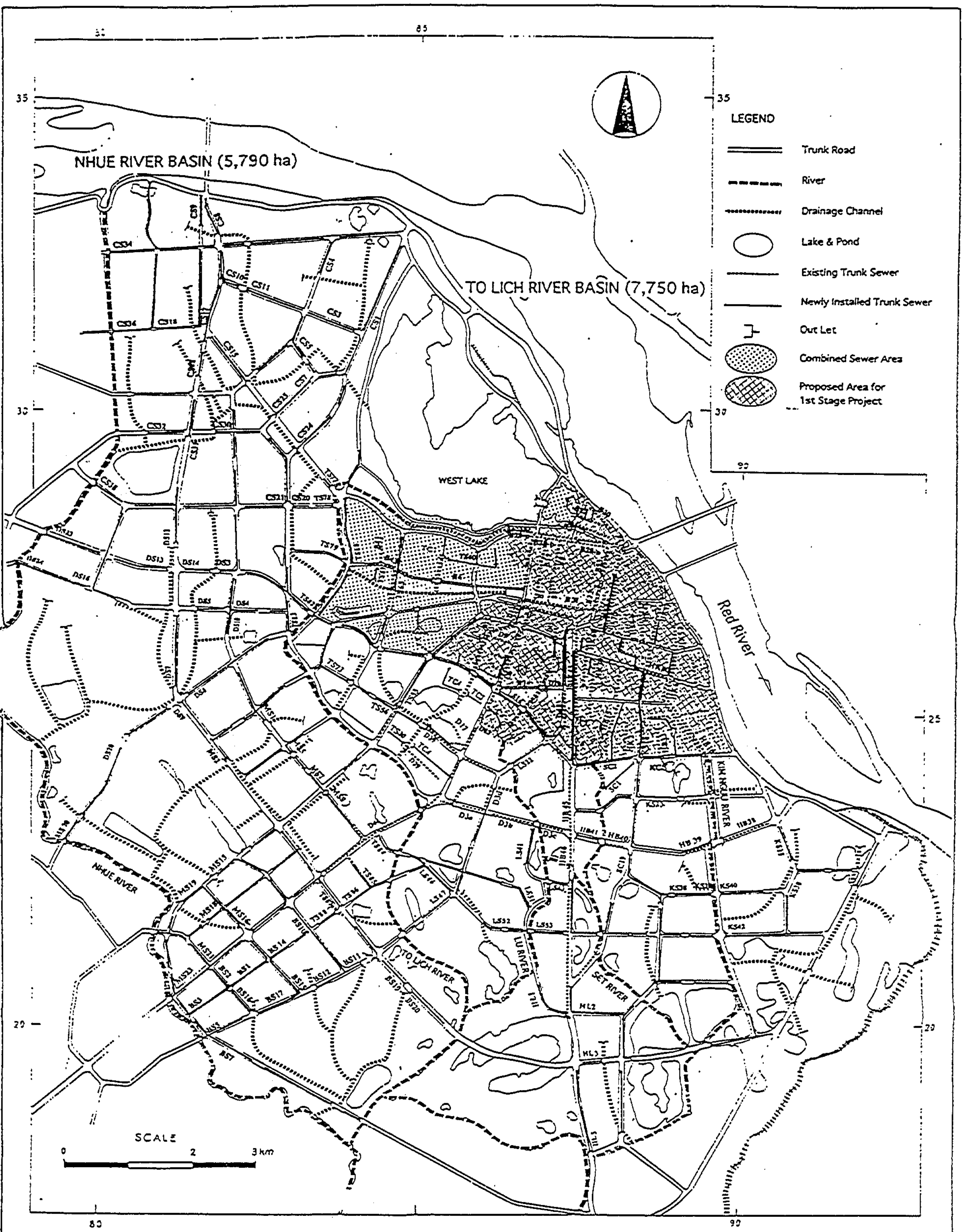
Unit : US$1,000

Item	Total	Year												
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
II. NHUE RIVER BASIN														
Me Tri Basin														
1) Construction Cost	30,801						6,951	7,715	8,420	7,715				
a. Drainage Improvement	16,799						4,199	4,200	4,200	4,200				
b. Nhue River Left Levee	452								452					
c. Sewer Construction	11,011						2,752	2,753	2,753	2,753				
d. River/Lake Conservation	2,539							762	1,015	762				
2) Administration Cost	924				185	139	185	139	138	138				
3) Land Acquisition and Compensation Cost	12,791				3,837	3,838	2,558	2,558						
4) Engineering Service Cost	4,620				924	462	924	924	924	462				
5) Sub-total	49,136				4,946	4,439	10,618	11,336	9,482	8,315				
6) Physical Contingency	4,914				495	444	1,062	1,134	948	832				
Total	54,050				5,441	4,883	11,680	12,470	10,430	9,147				

Table 6.2.2 DISBURSEMENT SCHEDULE FOR DRAINAGE MASTER PLAN (6/6)

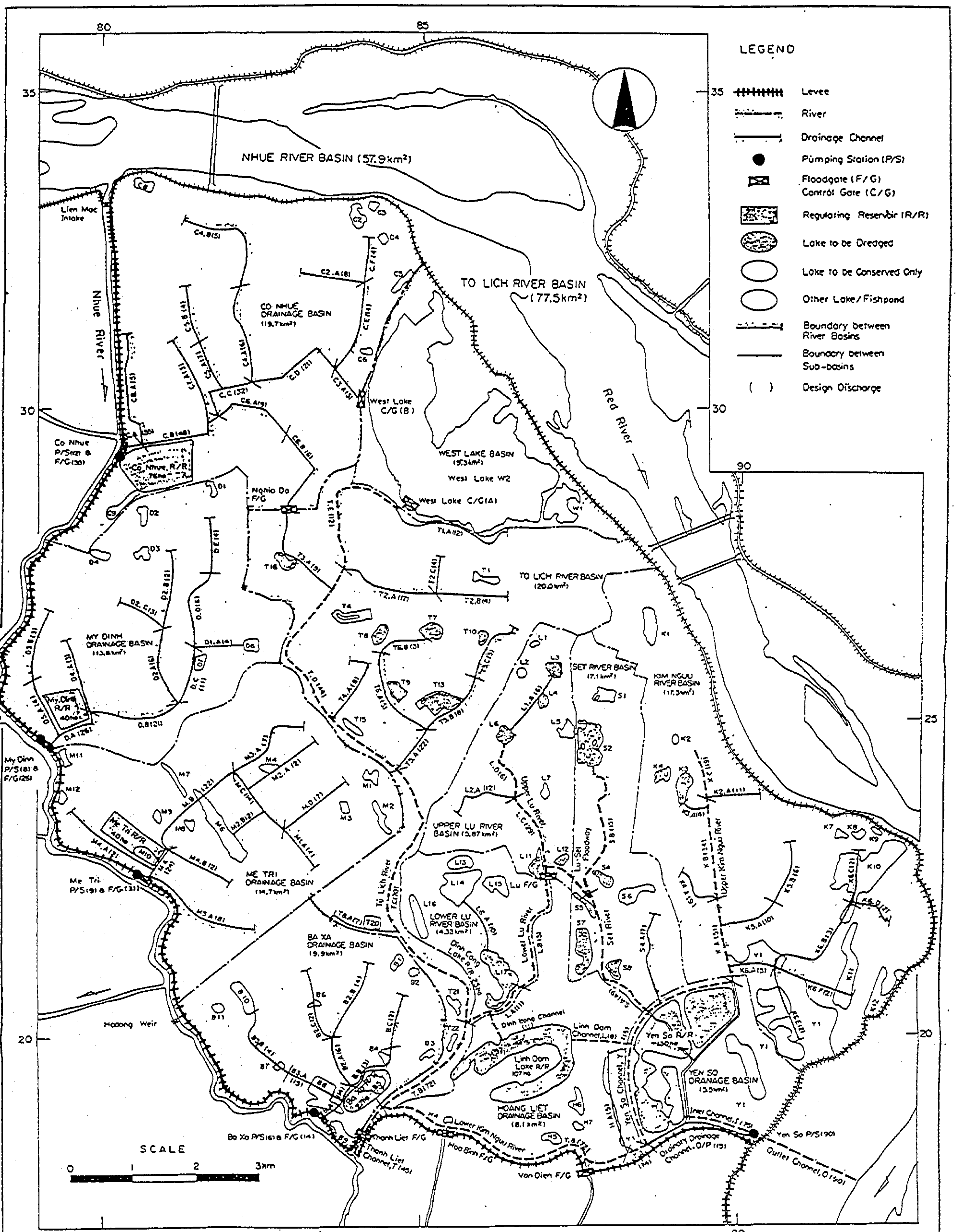
Unit : US$1,000

Item	Total	Year												
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
II. NHUE RIVER BASIN														
Ba Xa Basin														
1) Construction Cost	18,510										4,103	4,618	5,173	4,616
a. Drainage Improvement	10,877										2,719	2,720	2,719	2,719
b. Nhue River Left Levee	386												386	
c. Sewer Constuioction	5,537										1,384	1,385	1,384	1,384
d. River/Lake Conservatio	1,710											513	684	513
2) Administration Cost	555								111	83	111	84	83	83
3) Land Acquisition and Compensation Cost	1,995								599	598	399	399		
4) Engineering Service Cost	2,777								555	278	555	555	555	278
5) Sub-total	23,837								1,265	959	5,168	5,656	5,811	4,977
6) Physical Contingency	2,384								127	96	517	566	581	498
Total	26,221								1,392	1,055	5,685	6,222	6,392	5,475



JAPAN INTERNATIONAL COOPERETION AGENCY

Fig. 6.2.1
LAYOUT PLAN OF
URBAN DRAINAGE SYSTEM



Note :

Study results in the Feasibility Study are also reflected on this plan.

Fig. 6.2.2

LAYOUT OF DRAINAGE MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 6.2.3 Implementation Schedule of Flood Control & Drainage Project

No.	Proposed Project	Cost US$ mil		Remark
A.	TO LICH RIVER BASIN DRAINAGE PROJECT	318		
	A1. The 1st Stage Project	164		The 1st Stage Project is financed by OECF loan program
	(1) Yen So Pump Station (45m3/s)			
	(2) Regulating Reservoir (130ha)		(Yen So Reservoir)	
	(3) River Improvement W/Gates (33km)			
	(4) Drainage Channel Improvement (54 Box culverts)			
	(5) Supply of Dredging/Cleaning Equipment: C1			
	(6) Lake Dredging (4 lakes)/Aeration (2 lakes)		(Additional installation in parallel	
	(7) Rehabilitation of existing stormwater sewers		with the construction of new city road)	
	A2. The 2nd Stage Project	154		The 2nd Stage Project is proposed for OECF loan
	(1) Yen So Pump Station (45m3/s)			
	(2) Regulating Reservoir (132ha)		(Linh Dam/Dinh Cong Lakes)	
	(3) Drainage Channel Improvement (31km)			
	(4) Lake Dredging (14 main lakes)			
	(5) Lakeshore Protection Works (11 lakes)			
	(6) Rehabilitation of existing stormwater sewers		(Additional installation in parallel	
	(7) Installation of new stormwater sewers		with the construction of new city road)	
B.	NHUE RIVER BASIN DRAINAGE PROJECT	208		F/S is required
	B1. Co Nhue Sub-basin Drainage Project	87		1st priority area in Nhue basin
	(1) Pump Station/Reservoir/Channels		(Additional installation in parallel	
	(2) Stormwater sewers		with the construction of new road)	
	B2. My Dinh and Me Tri Sub-basins Drainage Project	95		2 sub-basin projects in parallel
	(1) Pump Station/Reservoir/Channels		(Additional installation in parallel	
	(2) Stormwater sewers		with the construction of new road)	
	B3. Ta Xa Sub-basin Drainage Project	26		
	(1) Pump Station/Reservoir/Channels		(Additional installation in parallel	
	(2) Stormwater sewers		with the construction of new road)	
C.	EXISTING SEWER/CHANNEL DREDGING PROJECT	20		
	C1. Supply of Dredging/Cleaning Equipment: A1.(5)	10		Included into A1. The 1 Stage Project
	C2. Dredging/Cleaning Work	(10)	Initial Dredging / Continous Dredging	(By HSDC)
D.	HANOI DYKE SYSTEM PROTECTING PROJECT	52	(On-going Project Under ADB)	Project under ADB loan Program
	D.1 Phase I (45 km)	36		
	D.2 Phase II (16 km)	16		
E.	NON-STRUCTURAL MEASURES	(5)		
	E1 Flood Plain Management	HPC		Land use control
	E2. Provision of On-site Storage for New Estate Development	Private		Strengthening of regulations
	E3. Flood Forecasting and Warning System	MOALD	(On-going Project Under ADB)	For the Red River
	E4. Public Information and Education Programme	(5)		(By HPC)

Legend: Study; Design; Financing/Tender-Contract; Construction; Intermittent Implementation

( ) Approx. Estimate

Cost : 1999 Base Price (excl. price contingency)