6.3 Measures and Projects for Achieving a Clean Water Environment

6.3.1 Basic Concept for Plan Formulation

(1) Planning Condition

1) Basic Concept

For the achievement of a clean water environment in Hanoi City, the Study Team sets up three slogans, 1) Protection of Human Health, 2) Conservation of the Living Environment, 3) Creation of Attractive Waterfronts.

(a) Protection of Human Health

Water pollution by toxic materials has a serious impact on human health. Treatment and management of toxic materials is the minimum requirement. Toxic materials (Cadmium, Lead, Chromium, Arsenic, Mercury, etc.) are generated from a limited number of industrial activities. The control method is to prohibit industrial factories or other activities from discharging wastewater that does not meet the standard.

At present, pollution caused by toxic materials is not serious in Hanoi City. However, preventive measures should be carried out to remove the fear of damage to human health caused by toxic material pollution.

In light of the above, the Study Team recommends the following:

- Reinforcement of the inspection system for operating industrial factories to maintain industrial effluent standards
- Reinforcement of the EIA check system for planned industrial factories prior to approval for commencement of construction.

(An industrial effluent standard has been set up, and DOSTE has an inspection system for industrial plants.)

(b) Conservation of the Living Environment

For conservation of the living environment, all wastewater generated in Hanoi City should be treated properly. However, establishment of wastewater treatment systems throughout the Study area is expected to take a long time and a large amount of expenditure. Establishment of the system should be carried out step by step.

The basic concept of sewerage system development is as listed below.

Areas with high population density and/or high BOD pollution area have high priority in establishing sewerage systems

Areas in the basins of high polluted water bodies, such as urban rivers (To

Lich River, Lu River, Set River and Kim Nguu River) or attractive water areas, such as West Lake and other urban lakes also have high priority in establishing sewerage systems

The new development area, which is not large in size, but expected to be expanded rapidly, such as new industrial and housing estates shall be required to have small scale sewerage systems

Except for these areas, on-site treatment facilities are to be installed properly and a proper septage collection system should be established.

a) Sewerage System Development

Sewerage system development is planned in light of these concepts. Hanoi Sewerage and Drainage Company (HSDC) is responsible for planning, design, construction and operation, and maintenance of the public sewerage system. Targets to 2005, 2010, and 2020 are established separately.

The target for 2005 to be established

	Area	Population in 2020	Wastewater in 2020	Population Density	River Basin
1) Pilot Sewerage Project in Parts of Kim Lien and Truc Bach Area	-	-	-	-	Kim Nguu R. & Truc Bach
2) Small Size Public Sewerage Systems in Waste Lake Basin	(930)	(57,000)	(14,820)	(167)	West Lake
3) Kim Nguu and Set River Basin Sewerage System, Phase 1	1,033	255,000	66,300	247	Kim Nguu & Set R.
4) Sewerage System in Tang Long New Development Area	2,110	138,000	49,900	(79)	-

The target for 2010 to be established

	Area	Population in 2020	Wastewater in 2020	Population Density	River Basin
1) To Lich River Upper Basin Sewerage System	1,350	299,000	77,740	222	To Lich R.
2) Lu River Upper Basin Sewerage System in To Lich River Basin	500	135,800	35,308	272	Lu R.

The target for 2020 to be established

	Area	Population in 2020	Wastewater in 2020	Population Density	River Basin
1) Kim Nhuu and Set River Basin Sewerage System, Phase 2	1,010	135,000	40,400	111	Kim Ngưu R.
2) Hanoi South Area Sewerage System, Phase 1	970	112,500	30,820	116	Nhue R. & To Lich R.
3) Nhue River Left Bank Upper Area Sewerage System	2,405	175,500	45,630	73	Nhue R.
4) Hanoi South Area Sewerage System, Phase 2	1,898	149,500	43,550	79	Nhue R.

b) Community Plant (Industrial Estate, Housing Estate)

When a certain area such as industrial estate, housing estate, and/or business center is newly developed, the developer should prepare a community wastewater treatment system in the area. The system is to be operated according to the polluter-pays principle.

c) On site treatment facilities

Large numbers of houses already have on-site wastewater treatment facilities such as septic tanks and vault latrines. However, insufficient maintenance of the facilities makes them inoperative. It is necessary to collect septage frequently and efficiently. URENCO has responsibility for setpage collection in Hanoi. However, URENCO has an obvious shortage of septage collection vehicles and of treatment capacity.

The master plan for septage collection is focused on the urban area.

Target septage collection rate in 2020 is 90 %.

Basically, collected septage is to be treated at wastewater treatment plants in the future. Septage treatment plants are to be constructed temporarily until completion of the sewage treatment plants.

All the existing septage collection vehicles are to be replaced because the vehicles are too old. Additional septage collection vehicles are to be procured gradually to meet the septage treatment plan.

Basic elements of the septage collection and treatment plan are shown below.

Septage Collection and Treatment Plan

	Target to 2005	Target to 2010	Target to 2020
Hanoi Central	35 % (from 21%) 95m³/day	84% 124m³/day	90% 16m3/day
Gia Lam	55% (from 15%) 20m³/day	85% 35m³/day	90% -
Dong Anh	35% (from 5%) 14m³/day	55% 23m³/day	90% 82m3/day

*) Upper row shows Septage Collection Rate, Lower row shows Septage Collection Amount

The objectives of the septage collection and treatment plan are as follows:

- To prepare sludge collection vehicles to meet the septage collection plan
- To prepare septage treatment plants to compensate for the shortage of treatment capacity of sewerage system.

(c) Creation of Attractive Waterfronts

Waterfronts are useful areas for recreation of residents and are also a tourism attraction. There are many small lakes in the Hanoi City urban area. For the improvement of waterfront conditions, projects are required not only for water quality improvement but also for preparation of proper infrastructure around lake sites.

The master plan is focused on West Lake and 64 small lakes in the urban area of Hanoi City. "West Lake Improvement Project" and "City Lake Improvement Project" are proposed in the master plan as shown below.

Septage Collection and Treatment Plan

	Target to 2005	Target to 2010	Target to 2020
West Lake Environmental Improvement	All works to be completed	-	-
City Lake Improvement	Projects to 14 Lakes to be completed	-	Projects to50 Lakes to be completed

3) Classification of wastewater disposal system

(a) Wastewater collection system

Wastewater collection systems to be applied practically in the Hanoi are classified into three as follows:

Classification of Wastewater Collection System

Item of Characteristics	Combine System	Separate System	Partially Separate System
Environmental Protection	*	***	**
Construction Cost	***	*	**
Workability of O&M	**	***	*
Silting inside Sewer	*	***	**
Complication	**	***	*
Required Space for Sewer	***	*	**
Buried Depth of Sewer	***	*	**

(Note) ***: Advantageous
** : Moderate
* : Inferior

For the present urban area, the existing combined system at the Old City Center will remain in effective use. As for the other areas, the most suitable from the above systems will be adopted, according to their local conditions and land use plan for 2020. In principle, sewerage area to be newly developed should be planned by a separate sewer system from viewpoints of environmental protection and workability of O&M.

(b) Wastewater disposal system

For the treatment of wastewater, the following three systems are considered to be appropriate:

i) On-site disposal system: to treat wastewater at each house/building/factory individually: This system includes two methods, simple on-site treatment method to treat toilet wastewater only and high-level on-site treatment method to treat both toilet wastewater and gray water.

ii) Community disposal system: to treat wastewater at each community zone, such as housing/industrial estates and business centers.

iii) Centralized disposal system: to treat wastewater using the public sewerage system.

Commercial wastewater should be treated by the same system as domestic wastewater. However, industrial wastewater will be treated individually or communally by a proper system based on polluters-pay principle. In the case of connecting with the public sewerage system, industrial wastewater should be pretreated according to the level of acceptable effluent limits (400 mg/l as BOD level).

The scale of the centralized disposal system is classified, according to the designed sewered population and service area as follows;

i) Small scale disposal system:less than 100,000 or less than 5 km^2

ii) Medium scale disposal system:100,000 - 300,000 or less than 10 km^2

iii) Large scale disposal system:more than 300,000 or more than 10 km^2

The schematic wastewater disposal system for each scale is shown in Figure 6.3.1.

The formulation of disposal system in the whole city area will be a combination of the above three different scale systems, which would be implemented by area and in stages. One medium scale system will be proposed instead of several small systems and one large system instead of several medium scale systems, as appropriate.

(2) Zoning and Treatment Methods

Sewerage development plan is formulated based on the approach as shown in Figure 6.3.2 taking into consideration of the above-mentioned planning conditions.

1) Conceptual Treatment Zoning Plan

Sewerage development zones should be delineated based on the following technical factors, especially considering the quantities of sewage and pollution load and geographic conditions.

- Zoning according to Environmental Zones to be prepared in this Study
- Zoning according to drainage basins
- Zoning according to land use (present and future)
- Zoning according to population density (present and future)
- Zoning according to wastewater and pollution load generation
- Zoning according to the configuration of wastewater disposal systems
- Zoning according to the sewage collection system, particularly the existing sewer systems
- Zoning according to the existing sewerage master plan prepared by UPI of HPC

The primarily conceptual treatment zoning plan in the whole area of Hanoi and the urban area, based on the above, is proposed as shown in Figures 6.3.3 and 6.3.4 respectively. The plan envisages dividing the Nhue River basin into eight treatment zones and the subdistricts into nine treatment zones. Characteristics of each proposed treatment zone at the Nhue Rivr basin and the subdistricts are defined in Table 6.3.1 and 6.3.2, respectively. The

planning conditions of the proposed public wastewater treatment zones are summarized below:

The planning conditions of the proposed public wastewater treatment zones

Treatment Zone	Environmental Zone	Service Area (ha)	Population in 2020	Wastewater in 2020 (m^3/d)	Scale
U.T.Zone 1-1	Ho Tay Area	930	57,000	14,800	Small
U.T.Zone2	Old City Center & Red River Right South	2,250	390,000	106,700	Large
U.T.Zone 3	Old City Center	1,350	299,000	77,700	Medium
U.T.Zone 4	Old City Center	500	135,800	35,300	Medium
U.T.Zone 5	Red River Right North West	2,410	175,500	45,600	Large
U.T.Zone 6	Red River Right North West & South	2,870	262,000	74,300	Large
G.T.Zone 1	Gia Lam Urban Area	4,100	311,000	101,300	Large
G.T.Zone 2	Gia Lam Urban Area	200	17,000	4,400	Small
D.T.Zone 1	Dong Anh Urban Area	550	75,000	19,500	Small
D.T.Zone 2	Dong Anh Urban Area	660	75,000	19,500	Small
D.T.Zone 3	Dong Anh Urban Area	2,110	138,000	49,900	Large

2) Wastewater Treatment Method

The relative merits of practical treatment methods were evaluated by comparing several typical treatment methods, taking into account overload flexibility, the level of technology required for operation and maintenance (O&M) work, adaptability for excess sludge disposal and land acquisition. This is shown in Table 6.3.3. The process of typical wastewater treatment methods is illustrated in Figure 6.3.5.

From a viewpoint of suitability at the Urban area, the results of the comparison between the Oxidation Ditch (OD) method, conventional Activated Sludge (AS) method and the Stabilization Pond (SP) are summarized below:

The results of the comparison

Item	OD Method	AS Method	SP Method
Required Area of Facilities (m^2/m^3) *1	0.7	0.3	8.9
Required motors capacity (w/m^3) *2	6.5	15.3	2.0
Sludge Production to wastewater (%) *3	0.2	0.3	— *4
Relative Construction Cost (OD:100%)			
- Machinery and Equipment	100	150	
- Civil Works	100	60	
- Total	100	130	40
O&M Cost (OD:100%)	100	120	50
	Recommended	—	—

*1 Required areas are only calculated to a wastewater yield.

*2 Required motors capacities per a wastewater yield are only calculated for the main plant facilities.

*3 Percentage is calculated by sludge production to a wastewater yield.

*4 There is no theoretic yield of excess sludge.

The Oxidation Ditch method (highest rating in Table 6.3.3) will be recommended in the urban area, and in the subdistricts the Stabilization Pond method maybe is recommended since the subdistricts have enough availability of lands for construction of the treatment plants.

The Oxidation Ditch method has been adopted in many developing countries and was evaluated as the most moderate all-round wastewater treatment method. The cost of public sewerage system for wastewater disposal, therefore, is based on the cost of the Oxidation Ditch method, for this study. The Schematic layout of the Oxidation Ditch method is shown in Figure 6.3.6.

The treatment plant capacity has been designed to reduce the BOD level of the wastewater from 334 mg/l to a level of 20 mg/l in the urban area and from 376 mg/l to a level of 20 mg/l in the subdistricts. This treatment BOD level satisfies the environmental standard of 20 mg/l BOD level in Vietnam.

3) Sludge Dewatering Method

Using the Oxidation Ditch process, total excess sludge yield from the whole study area is estimated at 863 m^3/d after sludge digestion tank treatment in the urban area and at 829 m^3/d in the sub-districts. Alternative studies on sludge dewatering facilities are examined as follows, in order to reduce the sludge weight and finally dispose of it at a dumping site. The following factors indicate relatively ratios in case that the dry beds method is 100%.

The factors of Sludge Dewatering Method

(Unit: %)

Factors	Dry beds	Mechanical Dehydrator	Incinerator *1
Volume of Dried Sludge	100	63-75 *2	13-19*3
Required Area of Facilities	100	30	60
Construction Cost	100	1,500	4,000
O&M Cost	100	1,500	4,000

Remarks *1: Dewatering facilities (dry beds/dehydrator) are necessary before incinerating.
*2: Volume of dried sludge is affected by the addition of a coagulant aid.
*3: Dependent on the water content of the dewatered sludge.

The Dry Beds method is recommended and dry beds are located adjacent to the wastewater treatment plant of U.T.Zones 2 and 5 in the urban area, and G.T.Zone 1 and D.T.Zone 2 in the sub-districts.

4) Potential Sites of Centralized Wastewater Treatment Plants

Site selection for centralized wastewater treatment plants is carried out according to the following concepts:

(a) The plants are to be located at sites where wastewater from sewered areas can be mostly collected by gravity flow.

(b) Sites have enough space for construction of the treatment facilities.

(c) The plants are to be located at sites where operation of the facilities will cause minimal environmental impact.

(d) Sites are to be adjacent to the receiving waters of the treated wastewater.

(e) Sites are to be selected from less extensive land use areas (eg., open spaces) both at present and also in the future.

(f) The plants are to be located at suitable sites in order for the treated wastewater to be reused as maintenance flow or flushing water for rivers and lakes/ponds in urban area during the dry season.

According to the future land use plan, available land for plant construction is limited. The potential sites for the treatment plants are identified below.

(a) U.T.Zone 1-1: Located at Buoi with more than 7 ha of available land, Ownership of Government, Present/future Land Use of the West Lake shoreline, or Located at Thuy Khe with more than 3 ha of available land, Ownership of Government, Present/future land use of green & park

(b) U.T.Zone 2 (located at U.T.Zone 7): Located at Tran Phu with more

than 350 ha of available land, Ownership of Private, Present/future land use of farmland/pond

(c) U.T.Zone 3: Located at Lang Ha with approximately 8 ha of available land, Ownership of Private, Present/future land use of Farmland/pond

(d) U.T.Zone 4 (located at U.T.Zone 6-1): Located at Bach Mai Airbase with approximately 5 ha of available land, Ownership of Government, Present/future Land Use: Military land

(e) U.T.Zones 3 & 4 (located at U.T.Zone 5): Located at Trung Hoa with approximately 8 ha of available land, Ownership of Private, Present/future land use of Farmland/residential

(f) U.T.Zone 5: Located at Metri with approximately 300 ha of available land, Ownership of Private, Present/future land use of Open space and farmland

(g) U.T.Zone 6: Located at Tan Trien with approximately 400 ha of available land, Ownership of Private, Present/future Land Use of Open space and farmland

(h) G.T.Zone 1: Located at Doug Du with approximately 200 ha of available land in Gia Lam, Ownership of Private, Present/future Land Use of farmland with ponds

(i) G.T.Zone 1: Located at northern part of Yen Vien with approximately 100 ha of available land in Gia Lam, Ownership of Private, Present/future Land Use of farmland

(j) D.T.Zones 1, 2 & 3: Located at Doung Hoi along the Red River with approximately 200 ha of available land in Doung Anh, Ownership of Private, Present/future Land Use of farmland with ponds

The location of wastewater treatment plants will be a subject to further review according actual social condition and land use when F/S is carried out.

5) General plan of public sewerage systems

The facilities of the public sewerage system in Hanoi are planned based on the following design criteria.

(a) Design Flow

Sewerage facilities, including sewers and wastewater treatment plants, shall be principally, designed, based on the design flow as follows:

The Design Flow for Sewerage Facilities

Collection System	Facilities	Design Flow
Separate System	Wastewater sewer	HMWF
	Pumping station	HMWF
	Primary/secondary treatments	DMWF
	Influent/ Effluent pipe	HMWF
Combined System	Combined sewer	HMWF + DSF
	Pumping station	HMWF + DSF
	Interceptor	> 3*HMWF
	Diversion Chamber	> DSF – 2*HMWF
	Receiving tank with pumps	> 3*HMWF
	Primary/secondary treatment plant	DMWF
	Chlorination tank	> 3*HMWF
	Influent/ Effluent pipe	> 3*HMWF

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

(b) Hydraulic design of the sewers is based on Manning's formula.

(c) Allowable flow velocity:0.6 - 3.0 m/sec for wastewater sewer and 0.8 - 3.0 m/sec for combined/stormwater sewer.

(d) The minimum velocity should not be less than 0.6 m/sec for the wastewater sewer and 0.8 m/sec for the combined/stormwater sewer in order to avoid sedimentation and to keep consistency with the onsite road gradient as much as possible. The maximum velocity should be limited to 3.0 m/sec in order to prevent the pipe from eroding.

(e) The allowance of the combined/stormwater sewer capacity will be 10% to 20% of the design flow. The allowance of pipe capacity to design flow for wastewater sewer is 100% for less than diameter of 600 mm, 50% for 700 mm to 1,500 and 25% for more than 1,500 mm. The above allowance is generally applied to select sewer pipes in consideration of unexpected flow fluctuation and to prevent the putrefaction of the sewage. The minimum size of pipe to be selected will be 200 mm for the wastewater sewer and 250 mm for the combined/stormwater sewer to secure the workability of maintenance & operation.

(f) 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 at 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 follows:

The maximum manhole interval for each size of sewer

Sewer Diameter (mm)	Maximum Interval (m)
< 300	50
< 600	75
< 1000	100
< 1500	150
> 1650	200

(h) A pipe bottom connection is recommended in view of the depth of the pipe laying and construction cost. However, water surface connection is proposed in case of a difference of diameters between connection sewers, so as to prevent backwater at the sewer pipeline.

(i) Pumping Station

The types of pumping stations are classified as follows according to their purpose, and the pumping facilities should be designed using the above-mentioned design flow:

Separate system

- Relay pumping station : designed by HMWF for lifting and transporting wastewater
- Stormwater pumping station : designed by DSF for discharge of stormwater
- Treatment plant pumping station : designed by HMWF for lifting wastewater

Combined system

- Relay pumping station : designed by (3· HMWF) for lifting and transporting wastewater
- Stormwater pumping station : designed by (DSF-2· HMWF) for discharge of stormwater
- Treatment plant Pumping station : designed by (3· HMWF) for lifting wastewater

The necessary number of pumps is recommended as follows, based on the Japanese standard:

- Wastewater pump: Design flow (m^3/sec) < 0.5 : 2 ~ 3 units (one is spare)
  0.5 ~ 1.5 : 3 ~ 5
  > 1.5 : 4 ~ 6

- Stormwater pump: Design flow(m^3/sec) < 3.0 :2 ~ 3 units (one is spare)
  3.0 ~ 5.0 :3 ~ 4
  > 5.0 :4 ~ 6

(j) Grit chamber

The design criteria of the grit chamber are recommended as follows:

- Number of grit chambers :> 2 units
- Bottom slope of grit chamber :1/100 ~ 2/100
- Mean velocity :0.3 m/sec
- Retention period :30 ~ 60 sec
- Depth of sand pit :> 30 cm
- Surface loading :1800 m^3/m^2· day for wastewater
  3600 m^3/m^2 - day for stormwater

(k) Screen

For wastewater, the screen is generally placed before the grit chamber, and for stormwater, it is located after the grit chamber.

(l) Manhole-type relay pumping station

In the case of HMWF being less than 0.5 m^3/sec, a manhole-type relay pumping station, with the following criteria, is allowable;

- Minimum diameter of pump suction: 80 mm
- Type of pump: Vertical detachable submersible pump
- Grit chamber and screen are not necessary

(m) Treatment Plant

An activated sludge process (oxidation ditch process) is recommended in treating the wastewater generated in the Study area, because biodegradable wastewater will be collected and treated via the centralized disposal system, while toxic/hazardous wastewater will be individually treated at each on-site disposal system.

The general design criteria of necessary facilities for the oxidation ditch process are proposed as follows;

- BOD-SS Loading :0.03 ~ 0.05 kg/SS kg· day
- MLSS :3000 ~ 5000 mg/l
- Aeration time :24 hours
- Return sludge ratio :50 ~ 150 %

- Flow velocity of bottom : 0.1 m/sec
- Number of ditch :> 2 ditches
- Depth of ditch :1 ~ 3 m
- Width of ditch :> 6 m

(n) Settling tank :

- Surface loading :20 ~ 30 m^3/m^2· day
- Settling time :> 2.5 hours
- Weir loading :< 150 m^3/m· day
- Number of tank :> 2 tanks
- Depth of tank :2.5 ~ 4 m

(o) Chlorination tank

A chlorination tank shall be designed for (DMWF) for the separate system and (3· HMWF) for the combined system respectively. Contact time is more than 15 minutes.

(p) Thickener is necessary for sludge dewatering facilities.

- Type of thickener: Gravity
- Moisture content of excess sludge : 99.3 ~ 99.5 %
- Moisture content of thickened sludge : 98.0 ~ 98.5 %
- Solid loading: 30 ~ 50 kg/m^2· day
- Number of tank: > 1 tank

(q) Dry beds is also necessary for sludge dewatering facilities.

- Depth of dry bed: 15 cm
- Drying time: 15 days

6.3.2 Institutional and Regulatory Measures

(1) Setting Appropriate Standards for Water Quality

1) Ambient water quality

The Surface Water Quality Standard (TCVN 5942-1995) was set up for conservation of surface water quality. As mentioned in Section 1.3.1, the standard indicates two levels of water quality for the following types of surface water.

Level A: for surface water used as a source of domestic water supply

Level B: for surface water used for purposes other than domestic water

supply.

Basically, Level B of the standard is adopted for water bodies in Hanoi, because most water supply sources in Hanoi are groundwater. Regarding BOD values which are typical indicators of organic pollution, Level A indicates 5 mg/L and Level B indicates 25 mg/L. With regard to the improvement of waterfronts and the living environment, the Study Team proposes BOD 10 mg/L as the standard for Hanoi. Generally, BOD 10 mg/L indicates odorless and no-blackish water.

The Groundwater Quality Standard (TCVN 5944-1995) was set up for conservation of groundwater. The level of the standard is quite reasonable.

2) Effluent standards

The Industrial Wastewater Discharge Standard (TCVN 5945-1995) was set up for the control of effluent of industrial factories. The standard indicates three levels of water quality standard as indicated below.

Level A: for discharge into water bodies used for domestic water supply.

Level B: for discharge into water bodies used for navigation or irrigation purposes or for bathing, aquatic breeding or cultivation.

Level C: for discharge to other water bodies

Level A of the standard is almost same as secondary treatment level (normal sewage treatment level). In the case of installation of central wastewater treatment systems in industrial zones, adoption of Level A is quite natural. All new industrial factories are expected to be constructed in industrial zones. Existing factories also have a tendency to move into industrial zones. It is recommended that central wastewater treatment systems should be installed in order to meet Level A of the standard in new industrial zones. It is also recommended that the industrial discharge standard should cover not only the industrial zones, but also other new development areas such as housing and office development areas.

(2) Reinforcement of Regulations and Law Enforcement

The overall approach to water pollution control is fivefold:

- setting appropriate discharge standards for all facilities
- development of compliance agreements to bring existing facilities into full compliance with standards
- establishment of more punitive systems for enforcement

- instituting a system of water pollution charges
- use existing and new EIA regulations on existing facilities to force new investments in pollution control measures

1) Appropriate Discharge Standards for all Facilities

The establishment of an effective system of water pollution control will require that effluent discharge standards be set for major industrial facilities in Hanoi City.

Discharge standards for effluents from facilities define the maximum acceptable quantity of pollutants that may be discharged into the ecosystem, area or region. Discharge standards must set for specific pollutants, and often are stated as concentrations, or as discharge rates to incorporate the time dimension. They usually are specific to an area or ecological zone, and may be set for specific industries.

Facility specific discharge standards should be based on the amount of a pollutant that may be discharged without causing the violation of water quality standards. For this to be done, the receiving environment (i.e., the current water quality conditions) for the pollutant must be characterized in terms of existing levels. Predicted changes in ambient concentrations resulting from the additional discharges should be compared against water quality conservation criteria.

2) Compliance agreements to gradually reach effluent standards

Existing pollution control regulations are not fully enforced because of insufficient enforcement capability of the Hanoi DOSTE. In addition, full compliance with the regulations will create economic hardship for existing enterprises. Furthermore, penalties, when considered appropriate are not always applied. At this time, it is neither practical nor possible to introduce strict discharge standards as that might force many facilities to cease operating. Instead, *progressive discharge standards* should be introduced with a specified timetable for implementation so that polluters have time to plan and prepare for the gradual modification of their operations to reduce effluent without severe economic hardship. This approach is to be incorporated into compliance agreements.

3) Penalties and Fines

Government regulation on punishment for administratively violating environmental protection legislation outlines the forms of punishment and the

responsibilities and authority for enforcement. The various articles provide for warnings and fines for violations for all large number of violations of LEP and supporting regulations. Unfortunately, fines are set at levels too low to act as disincentives to potential polluters. In addition, DOSTE inspection division has limited authority over national level industrial facilities and mining operations. For example, the Chief Inspector in DOSTE can not revoke a permit issued by the national level. This means that the Inspection Division of MOSTE will have to be involved in EMP Implementation to deal with Central level SOEs.

However, the system of administrative punishments should be reviewed. More punitive fine levels and other forms of punishment should be considered. The proposed institutional strengthening of the Inspection Division is designed to increase the enforcement capability. This combined with more severe punishments will provide for stronger means for investigating, prosecuting, and punishing serious polluters.

4) Water Pollution Charges

The command and control measures, discharge standards backed up by penalties and fines may not be completely effective. In many parts of the world regulators are increasingly becoming aware of the limitations of command and control approach. The major weaknesses of laws and regulations are their failure to take into account the changing environment and their tendency to be biased against technological innovation. While pollution licenses are in effect for a specified time period, abatement technology and environmental conditions are constantly changing. Once a license has been issued for a specific length of time, the polluter has little incentive to adapt to new economic, environmental or technological conditions or to control pollution beyond the level required.

Enforcement problems and skepticism about compliance with direct regulation have raised questions about the effectiveness and efficiency of imposing further regulation. The GOV is proposing to introduce mandatory pollution fees on wastewater discharges to create an incentive to reduce pollution. The introduction of pollution fees on wastewater discharges will greatly increase the likelihood of the attainment of EMP's environmental quality objectives.

5) EIA of Existing Facilities

The Environmental Protection Law requires that EIA reports are to be

prepared for existing facilities. These reports are essentially inspections and audits of the current environmental impacts associated with existing operations. Where these facilities fail to meet environmental standards they are required by the law to undertake remedial measures to reduce the environmental impacts. However few existing industries have the financial resources to conduct EIA of their operations and fewer still have the resources to undertake remedial actions. However, these industries are a serious cause of existing pollution and are a target for substantial improvement in environmental protection or they may face closure.

MOSTE will issuing new guidelines in 2000 that will require the facilities to prepare pollution abatement plans. These plans must be implemented within five years. It proposed to use the requirements for existing facilities to produce an EIA report to ensure that compliance agreements are prepared to gradually bring the serious polluting facilities into compliance with existing laws and regulations.

1) Short-term measures: By 2005

In short term, the following measures will be undertaken:

- developing of discharge standards
- review of administrative penalties for violation of pollution control laws
- complete pollution abatement plans based on EIA for all existing facilities

2) Middle-term measures: By 2010

In the middle term, the following measures will be undertaken:

- institution of water pollution charges for all major facilities
- completion of pollution abatement programs for all facilities

(3) Organizational Strengthening: HSDC (sewerage)

Organizational strengthening discussed in this section of the report deals with needs related to operation and maintenance of the sewerage 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 pollution and the cost-effective, 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 environment

- 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.
- maximize cost recovery in order to achieve financial autonomy by promoting self-financing (user pays) sanitation services
- improve maintenance levels to protect the significant investment in infrastructure
- 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 wastewater treatment plants and implement maintenance management systems.

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

HSDC Organisational Strengthening Framework

OBJECTIVE	SHORT TERM 2005	MID TERM 2010	LONG TERM 2020
Re-organize to suit new operational functions	Sewerage Functions: - Create new wastewater treatment enterprise - Create a pumping stations and regulator maintenance group within each sewer & drainage enterprise - Accept responsibility for septage collection. Create a new enterprise to collect septage and manage a new septage disposal facility in Gia Lam.	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	Sewerage Functions: - hire and train personnel to operate pilot treatment plants - hire and train laboratory personnel - 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.	Sewerage Functions: - hire and train more wastewater treatment plant operators and process engineers to meet the growing number of treatment plants Management Functions: - provide training on pricing strategies and tariff setting for cost recovery	Sewerage Functions: - develop technical skills required to support wastewater treatment plant operators

OBJECTIVE	SHORT TERM 2005	MID TERM 2010	LONG TERM 2020
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.
Implement maintenance management systems	Sewerage and Drainage Functions: - 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	Sewerage and Drainage Functions: - implement a work order system for scheduling of all preventive and emergency maintenance - develop a sewer inventory	Sewerage and Drainage Functions: - develop advanced preventive maintenance technologies
Provide technical support to operations	Sewerage Functions: - 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.	Sewerage Functions: - implement a sewer inspection unit within the engineering department - increase the capacity of the central laboratory	Sewerage and Drainage Functions: - 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:

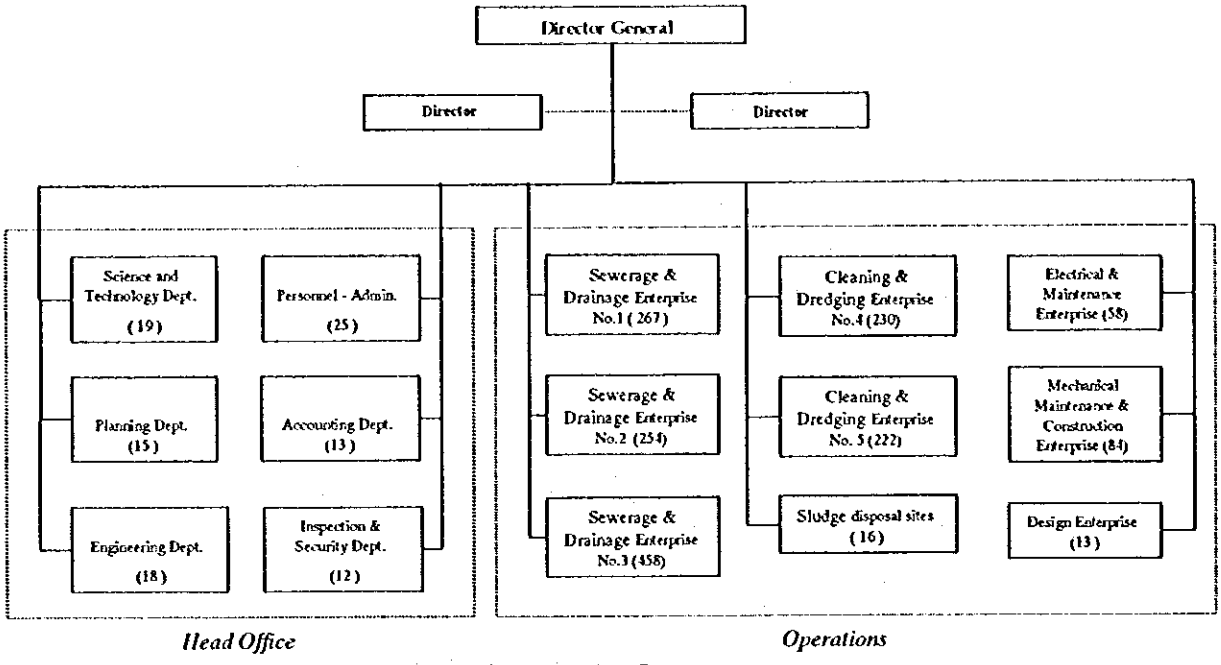
1) Short – term measures: 2005

(a) Wastewater Collection

At present HSDC carries out a number of tasks related to sewerage:

- Cleaning sewers and street drains
- Approval of sewer connections
- Rehabilitation of sewers

The existing organization presented below, is well structured for coping with maintenance of sewers and street drains.



Existing Organization Structure
(Brackets indicate number of staff)

Equipment and tools for cleaning sewers have recently been provided under the sewer rehabilitation component of the drainage improvement project funded by OECF. Recent increases in personnel have been made under the sewer cleaning and dredging project. These staffing levels will be adequate to cope with required maintenance and should be maintained until 2010.

As treatment becomes available the wastewater collection system will be improved and extended into urban areas. The number of maintenance personnel required will need to be increased and new M&E skills will be required for operation and maintenance of pump stations and regulators.

(b) Wastewater Treatment

Wastewater treatment facilities presently do not exist and will be gradually implemented over the planing period. In the short term, two pilot-scale wastewater treatment plant will be constructed as part of the drainage project funded by OECF and should be operational by the end of 2001. Based on experience gained at the pilot plants, a full-scale wastewater treatment will be constructed to serve treatment zone 2-1 by end of 2005.

The implementation of wastewater treatment will create a need to hire qualified and knowledgeable operators and engineers as well as trained mechanics and electricians. It is, therefore, important that HSDC move

quickly to hire and train technical personnel for treatment plant operations.

Operational control of wastewater treatment systems will require frequent sampling and laboratory analysis to monitor:

- Influent wastewater characteristics
- Effluent characteristics
- Performance of the treatment systems and
- Operating adjustments to various stages of the treatment process

Treatment plants will, therefore, need to be supported by a properly equipped laboratory and a team of technicians. Initially, the two pilot treatment plants will each have their own small laboratory for process control. However, with the completion of a full-scale treatment plant in 2005 it is recommended that a single, centrally located laboratory be constructed to provide lab services to all wastewater treatment plants operated by HSDC.

A central laboratory will facilitate standardization, make it possible to obtain consistent results, and reduce the duplication of lab equipment, space and personnel required to support several treatment plants. Sampling can be done on a rotational basis by a team of traveling laboratory technicians.

c) Organizational structure for operations and maintenance (O&M)

The organizational structure will need to be modified to reflect new operational and maintenance activities:

- operation and maintenance of new wastewater treatment plants
- operation and maintenance of new pumping stations and interceptor sewers

There are generally three options for maintenance organization:

- centralized
- decentralized
- combination centralized decentralized

Centralized maintenance provides a high degree of flexibility, good utilization of resources and facilitates record keeping. However the main disadvantage is the friction created between operations and maintenance groups in determining priorities and scheduling work. For this reason it is preferable to try and integrate operations and maintenance.

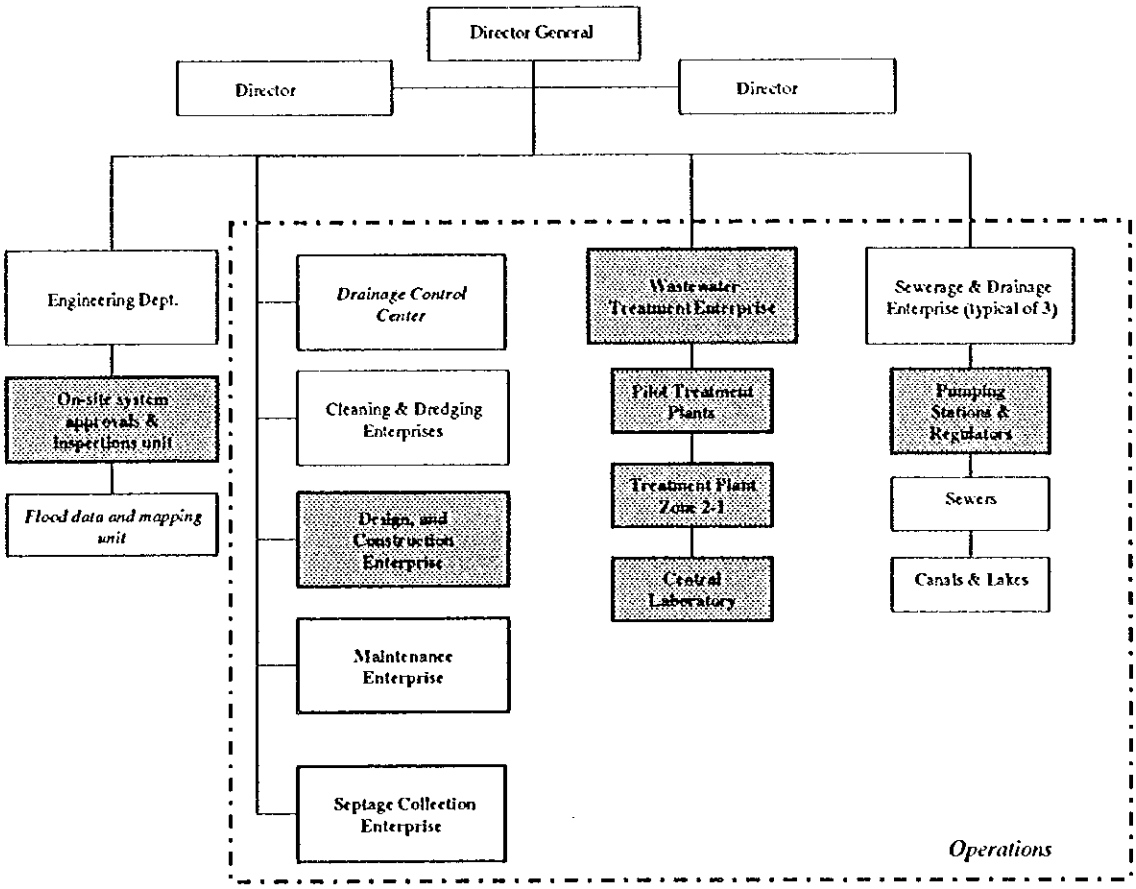
Decentralized maintenance brings maintenance and operations closer together with the advantage that maintenance crews are readily accessible and more responsive. Maintenance staff can become more familiar with the equipment and travel time is reduced. The main disadvantage is inadequate utilization of

resources.

A combination centralized-decentralized organization is recommended as a way of gaining the benefits provided by each option. The existing electrical and mechanical maintenance enterprises will need to be re-organized into a single maintenance enterprise to facilitate coordination of maintenance services. Regular preventive maintenance at sewage pumping stations and a small percentage of minor repairs can be carried out by small district based maintenance teams seconded from the maintenance enterprise to each of the three sewerage enterprises. Preventive maintenance and minor repairs will be carried out by a specialized group of skilled trade workers mechanics and electricians located at each treatment facility. The central maintenance enterprise will provide crews for major repairs.

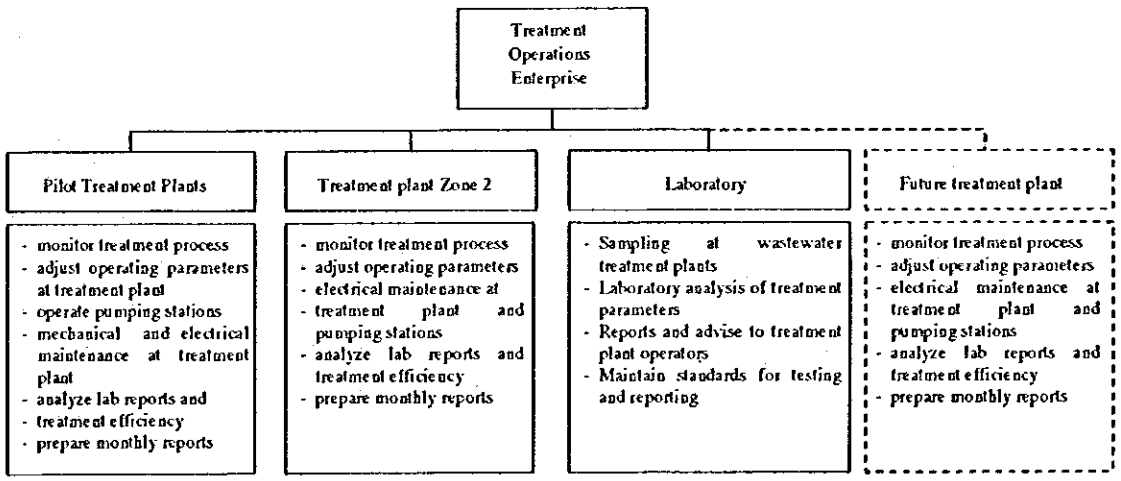
Trades people working at the treatment plant should be trained to understand the treatment process and the operating parameters that affect it.

It is recommended that a new Wastewater Treatment Enterprise be created for all operational aspects related to treatment including the laboratory. The short term organizational structure related to sewerage is presented below:



HSDC Organisation Structure for Sewerage – 2005 (simplified)

The new Wastewater Treatment Enterprise will have the following functional responsibilities:



Functional Organisation of Wastewater Treatment Enterprise: 2005

(d) Improved financial management

a) Revenue

Increased revenues are required to fund operations and maintenance, and eliminate subsidies to gradually transform HSDC into a financially autonomous entity operating on a commercial cost recovery basis.

Sewer revenues are based on a percentage of water supply billings. Therefore, in the short term, it is recommended that TUPWS urgently implement changes at the water supply company in order to improve water supply billings and thus sewer revenues. Required improvements consist of: i) increased number of metered connections, ii) improved billing and collection systems, and iii) increased customer registration.

Furthermore, funds collected for sewer surcharges should be transferred directly to HSDC. A special sewer fund must be created and for revenues from sewer surcharges. HSDC should be responsible for administrating the sewer fund.

b) Financial Management Information Systems

Achieving a commercially viable operation will require the implementation of a modern financial management information system to accurately identify and manage the costs of operation and maintenance.

To facilitate proper financial management it is recommended that HSDC implement an automated information system consisting of cost accounting, budget preparation, and reporting modules. Automation provides many benefits: (a) accurate and timely financial information on budgeted versus actual performance; (b) simplifies analysis of cost information to control expenditures; and (c) facilitates the abstraction of performance data required to prepare budgets.

The system would be used to provide meaningful and timely reports on the financial performance of the establishment. The heart of the system would be the cost accounting module, which would be used by the Accounting Department to record income & expenditure transactions, prepare trial balances, and control expenditures. The Planning Department would use the program to produce financial management reports highlighting budget expenditures to date, amounts remaining, budget variances (over/under spending) and other user defined.

2) Mid-term 2010

(a) Wastewater Collection

Increasing growth in the urban area of Gia Lam District will result in more sewers and drains. HSDC intends to assume responsibility for maintenance and operation of sewerage and drainage in Gia Lam. It is proposed that a fourth sewerage and drainage enterprise be created to provide maintenance services to Gia Lam.

The availability of treatment will open the way for expansion of the underground sewer reticulation system and result in a larger inventory of sewer pipes that will need to be inspected, cleaned and repaired. It will therefore be essential for HSDC to have a well-organized record keeping system to support proper maintenance and response to problems such as sewer blockages. It is recommended that a database, known as a "sewer inventory" be developed. The typical inventory includes information such as: pipe size, material, age, location, flow, repair history, location of connections. The sewer inventory can be developed as the first step in a larger sewer inspection and maintenance program that will be implemented over the mid-term to long-term. It is recommended that a specialized "sewer inspection unit" be created within the Engineering Department to develop the inventory.

(b) Wastewater treatment

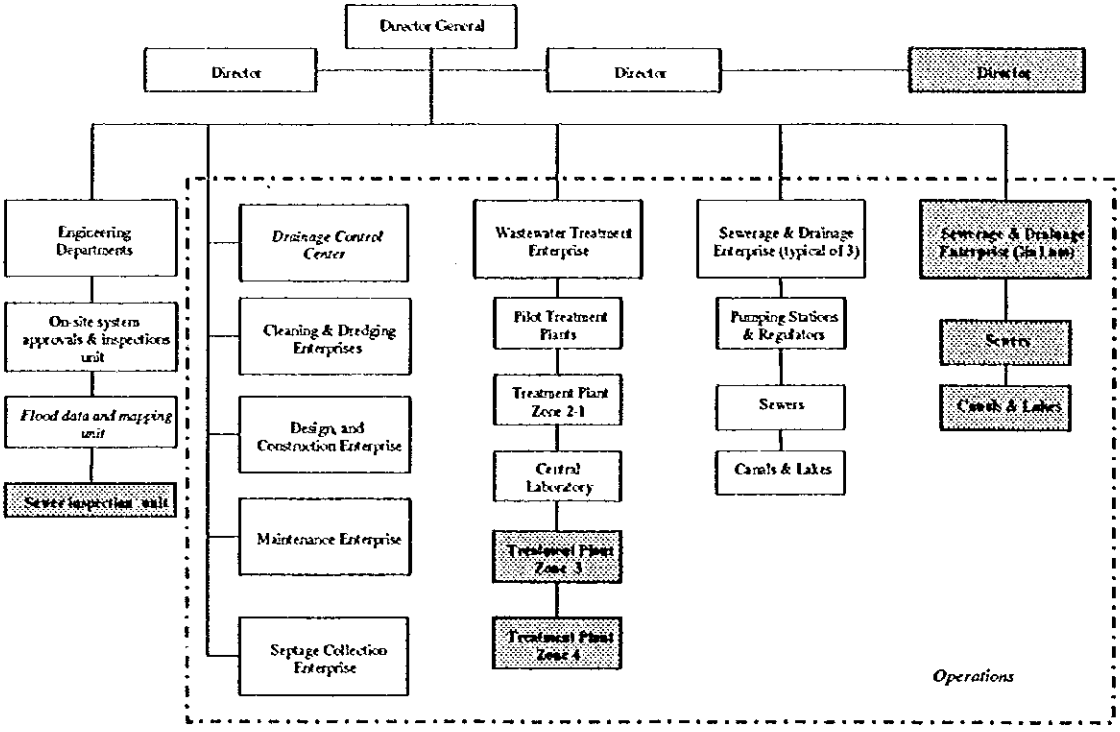
By 2010, two more wastewater treatment plants will be in operation. Personnel for operation and maintenance of new plants should be hired and trained before completion of the construction to ensure a smooth transition. Practical on-the-job training can take place at existing treatment plants. Equipment and personnel in the central lab will need to be increased to cope with the work load created by new treatment plants.

(c) Organisation for O&M

The organizational structure will need to be modified to reflect new operational and maintenance activities:

- operation and maintenance of new wastewater treatment plants
- maintenance of sewers and drains in Gia Lam urban area.

The recommended mid-term organizational structure presented hereunder is a logical extension of the previous short-term structure.



HSDC Organisational Structure for Sewerage: 2010

Each treatment plant will have its own operation and maintenance team. Major repairs and maintenance continue to be carried out centrally by the Maintenance Enterprise. Sewers and pumping stations are maintained by the Sewer & Drainage Enterprises.

(d) Financial management

HSDC will need to increase tariffs to cover the increasing costs of operating wastewater treatment plants.

A national water tariff policy study financed by the ADB was completed in March 1996 and the Government is presently reviewing its recommendations. The recommendations include a minimum monthly charge (covering $5m^3$ for domestic and $10m^3$ for non-domestic customers), a lifeline block (varying between 12 and $20m^3$/month depending on city size set at a minimum of 1,500 VND/m^3), a progressive tariff with three tariff bands, and a separate tariff for industrial and commercial consumers.

Changes in water tariffs will have a large impact on sewer revenues. Given that present cost data is inadequate and future operations will be substantially different from the existing ones, it is recommended that a tariff study be undertaken to review the adequacy and affordability of the present system of

tariffs and to propose modifications. The tariff policy adopted by HSDC should allow for progressive increases to eventually recover the full cost of providing services including capital costs associated with renewal and expansion of the system.

Further study is required to determine appropriate tariff structures and rates that will improve cost recovery within the limits of affordability. The World Bank is currently implementing sanitation projects in three cities: Da Nang, Haiphong, Quang Ninh. In all three cases the cities have agreed with the recommendation to implement wastewater charges based on a percentage of water supply billings. This approach was selected over the use of flat charges because there are several advantages to linking wastewater charges to water consumption. In particular is the more equitable spread of costs to higher consumption users. The World Bank also recommended that the charges collected by the water companies be remitted directly the Sewerage & Drainage Company with deduction of an appropriate administrative charge to cover the collection cost.

At present, budget planning is rather primitive and consists of reviewing the previous year's expenses and adding a small percentage as a contingency for increased costs. Presently there is no linkage between capital expansion budgets and operating budgets. As a result of this gap, HSDC may not have sufficient funds in its operating budget to hire staff, operate & maintain new facilities. If HSDC is to become financially autonomous it will need to forecast budget requirements sufficiently ahead to plan for appropriate increases in tariffs. Budgets should be forecasted at least on a five-year rolling forward basis.

(e) Maintenance management

A modern maintenance management system is regard to ensure adequate preventive maintenance of sewers, equipment and vehicles. The system should be automated and provide the following function:

- a sewer inventory database with connection, pipe size, type, age and condition assessment,
- preventive maintenance schedules, for sewers, mechanical and electrical equipment
- spare parts inventory control,
- Maintenance history and trend analysis to identify increases in costs related to aging.

The system would be used to provide regular preventive maintenance, record

emergency maintenance and operating problems, and support decisions regarding the economic cost/benefit of repair versus replacement.

3) Long-term 2020

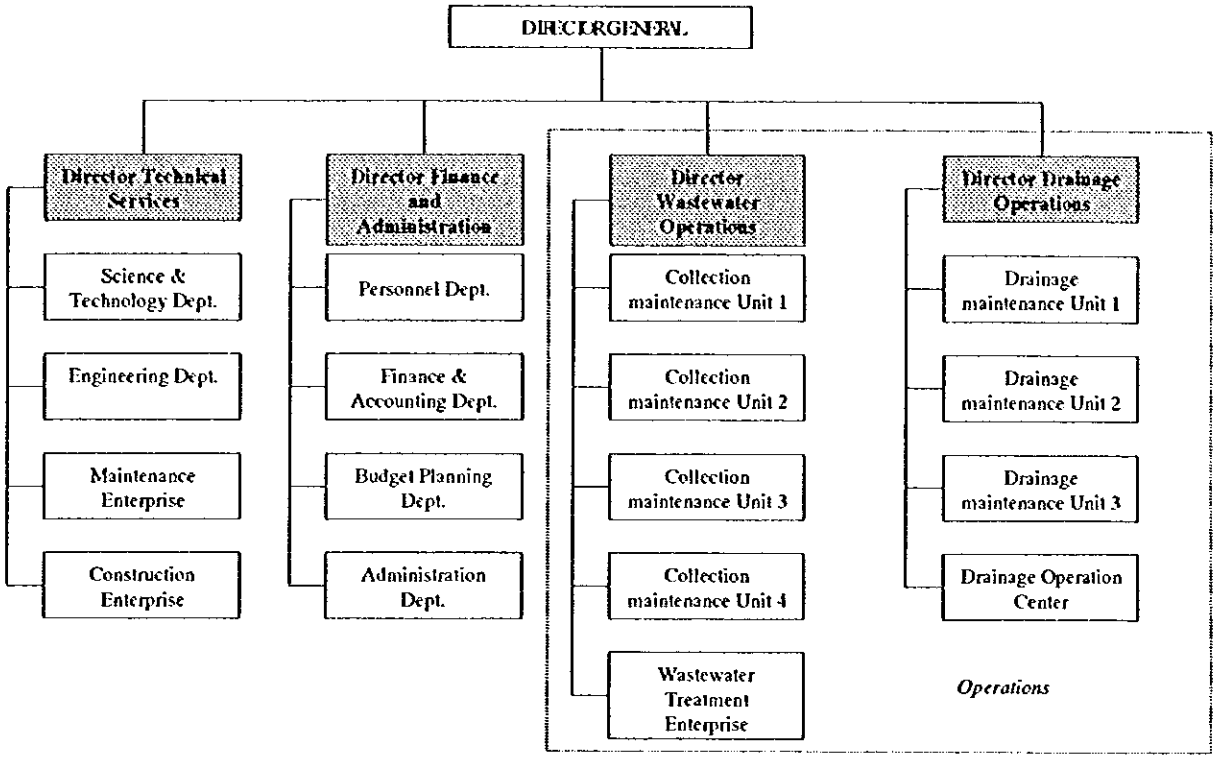
(a) Organization for O&M

The level of sewerage development activity planned for the period 2010 to 2020 is significant:

- Two more treatment plants in (zone 5 and 6)
- expansion of treatment plant for zone 2-2
- new treatment
- plant in Gia Lam
- extension of collection system coverage in urban areas to serve 90% of the population

The significant investment in sewerage infrastructure will require a corresponding increase in operation and maintenance levels. The organization will need to devote more resources to sewerage operations and must be re-organized to provide effective maintenance and quick response to sewer maintenance problems.

At this stage it is recommended that the drainage & sewerage functions be separated in order to allow a greater level of flexibility in responding to problems and a greater degree of specialization and ownership among staff. The proposed long-term organization of HSDC to cope with wastewater treatment and collection operations and maintenance is presented below.



HSDC Organisational Structure for Sewerage: 2011 to 2020

The organisation is restructured into four divisions: two operating divisions and two supporting headquarters divisions. Each division will have its own director responsible for directing middle managers in service. The directors will form a management team and report to the Director General.

Collection maintenance units will be organized on a district basis and will be responsible for:

- unblocking sewers
- assisting engineering department with inspection of sewers and manholes
- repairing sewers and manholes
- Pumping station operation and maintenance.

The functional responsibilities of the Wastewater Treatment Enterprise do not change but additional units will be added for each new treatment plant that becomes operational.

The Drainage Operation Center will continue to operate the Yen So flood control reservoir and gates. Drainage maintenance will be carried out separately from sewerage functions and focus on cleaning canals, lakes, and maintaining levees.

Functional groups that support operations should be grouped under a new

Technical Services Division to provide a higher level of technical competence to maintenance activities. The maintenance enterprise and the construction enterprise will continue to provide centralized maintenance services to wastewater and drainage divisions but will apply more technologically advanced maintenance management techniques to reduce operating and maintenance costs and prolong the life of infrastructure.

In the long term, accumulated depreciation of fixed assets should be kept in a separate fund and managed to ensure there is sufficient capital on hand to replace fixed assets at the end of their economic life cycle. Funds accumulated for asset replacement should not be used to cover other operating expenses or investment needs.

3) 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 6.3.4. Annual program costs are summarized as follows:

Staffing Requirement

DIVISION/ PROGRAM	NO. OF STAFF (end of period)		
	2000-2005	2006-2010	2011- 2020
Wastewater treatment	20	36	60
Collection system pump stations	10	20	35
Sewer inspection program	0	22	22
Sewer inventory	0	8	8
Total Investment costs (000's USD)	600	980	910
Annual Operating costs (000's USD)	201	495	748
HRD Training cost (000's USD)	340*	430*	17.5**

* 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.

6.3.3 Improvement of Wastewater Disposal System

The improvement plan of wastewater disposal system is proposed as shown in Figure 6.3.3. In this Study, the proposed public sewerage projects consist of nine projects: U.T.Zones 2 to 6, G.T.Zones 1 to 2 and D.T.Zones 1 to2 since U.T.Zone 1-1 and D.T.Zone 3 are under implementation by Vietnamese Government. The total construction cost of the proposed nine public sewerage projects is estimated at US$ 509 million as shown in Table 6.3.5.

As the public sewerage projects are obvious to require huge costs of implementation and O&M as estimated in Table 6.3.5, the implementation of the projects should be phased from viewpoints of city development plan, social needs, environmental requirements, and financial and economic conditions. It is also recommended that the public sewerage projects be implemented in harmonization with city development, drainage projects and lake conservation projects on account of being strongly related to each project.

The priority of zones to develop the wastewater disposal system, is assessed as shown in Table 6.6.5, based on the conceptual zoning plan and the characteristics of each zone. The priority of zones for sewerage development is recommended, as follows, in consideration of the index of the benefit (removed pollutant load as BOD levels: kg) per construction cost (million US$) and the influence in receiving improved water quality.

- In the urban area,U.T.Zones 2-1, 4, 3, 2-2, 6-1, 5 and 6-2 using the centralized disposal system
- In the sub-urban districts, G.T.Zones 1 and 2, D.T.Zones 1 and 2 using the centralized disposal system

Wastewater treatment facilities in U.T.Zones 1-2, 7 and 8, G.T.Zone 3, and D.T.Zones 4 and 5 where are recommended using on-site/community disposal system will be constructed by each polluter according to the polluter pay principle.

Implementation schedule of the public sewerage projects is proposed as shown in Figure 6.3.7 and the proposed projects at each targeted year are described below according to each target year of environmental improvement:

(1) Short-term measures: by 2005

1) Priority projects

The project of U.T.Zone 2 covering the Environmental Zones: Old City Center and Red River Right Bank-South are selected for the priority projects and number of beneficiaries is estimated at 390,000 persons in 2020. The U.T.Zone 2 divided further into two sub-zones: U.T.Zone 2-1 for the Old

City Center and U.T.Zone 2-2 for the Red River Right Bank-South.

The project area is the city core center belonging to the Kim Nguu River basin and has the most historical lake of the Hoan Kiem Lake. In order to improve seriously polluted living environment, the following measure are necessary:

Outline of Priority Projects

Project Components	U.T.Zone 2-1	U.T.Zone 2-2
3) Service Area (ha)	1,033	1,220
- Separate System	233	1,000
- Partially Separate System	800	220
4) Interceptor & Diversion Chamber (unit)	4	-
3) Relay Pumping Station (unit)	2	-
4) Wastewater Treatment Plant (m^3/d)	66,300	40,400

U.T.Zone 2-2 will be implemented after completion of U.T.Zones 3 and 4 covering the whole area of the Old City Center according to assessment of priority for development.

2) Other short-term measures

The following non-structural measures are proposed to be undertaken as activities associated with the public sewerage development.

(a) Government Support for Installation of Flush toilets

The following government support is necessary as local latrines (pit latrine or bucket latrine) should be upgraded to flush toilets w/septic tanks in accordance with the sewerage development.

- Financial back-up to people through provision of a soft loan with a revolving fund system for flush toilet installation.
- Sponsorship to educate the public regarding the necessity of flush toilets
- The enforcement of installing flush toilet installation, establishing legal regulations in newly developed areas.

These measures are particularly required in U.T.Zones 1-2, 7 and 8, G.T.Zone 3, D.T.Zones 4 and 5, and Soc Son suburban district where on-site/community treatment systems are proposed.

(b) "Care for Drainage/Sewerage" Campaign

Dumping of domestic solid waste is one of the main reasons of pollution in the rivers and lakes. "Care for drainage/sewerage" campaign should be sponsored and carried out by the government. The campaign is to educate the people of the need of drainage/sewerage facilities and water disposal practices, in accordance with the regulations.

(c) Regulations for Installation of Effluent Pre-treatment

Regulations on the installation of wastewater pre-treatment by industries should be enforced to reduce the pollutant load in the public wastewater disposal system.

Additionally, solid waste and nightsoil collection systems are required to be improved by URENCO as described later.

(2) Middle-term measures: 2010

The project of U.T.Zones 3 and 4 cover the Environmental Zones: Old City Center which living environment is polluted seriously by wastewater discharged from households, hospitals, factories, and so on. In order to achieve the target of clean water environment as mentioned in the Section 5.2.2, the following measure are required and implemented by 2010:

Outline of Middle-term Projects

Project Components	U.T.Zone 3	U.T.Zone 4
1) Service Area (ha)	1,350	500
- Separate System	160	110
- Partially Separate System	1,190	390
2) Interceptor & Diversion Chamber (unit)	7	8
3) Relay Pumping Station (unit)	7	3
4) Wastewater Treatment Plant (m^3/d)	77,700	35,300

(3) Long-term measures: by 2020

In order to improve the public sewerage system in the whole targeted area of the environmental zones, the following projects will be implemented by 2020:

Outline of Long-term Projects

Project Components	U.T.Zone 5	U.T.Zone 6	U.T.Zone 2-2	G.T.Zone 2
1) Service Area (ha)	2,405	2,868	1,220	200
- Separate System	2,405	2,868	1,000	200
- Partially Separate System			220	
2) Interceptor & Diversion Chamber (unit)	-	-	-	-
3) Relay Pumping Station (unit)	2	3		1
4) Wastewater Treatment Plant (m^3/d)	45,600	74,300	40,400	4,400

From the financial aspect in HPC, the implementation schedule of the following long-term projects is postponed until 2025.

Outline of Postponed Long-term Projects

Project Components	G.T.Zone 1	D.T.Zone 1	D.T.Zone 2
1) Service Area (ha)	4,095	550	660
- Separate System	3,704	550	660
- Partially Separate System	391		
2) Interceptor & Diversion Chamber (unit)	5	-	-
3) Relay Pumping Station (unit)	5	3	3
4) Wastewater Treatment Plant (m^3/d)	101,300	19,500	19,500

(4) Project cost estimate and implementation schedule

Project cost of the public sewerage projects is estimated as shown in Table 6.3.5 under the following conditions of cost estimate:

a) Adoption of unit prices in Vietnam at the place level of 999
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

Figure 6.3.8 also indicates the disbursement schedule at each drainage projects according to the recommended implementation schedule as shown in Figure 6.3.7. The cost of the urban drainage project and annual O&M cost at each drainage basin is summarized below:

The cost of the urban drainage project and annual O&M cost

(Unit: US$1,000)

Sewerage Project	Project Cost	Annual O&M Cost	Implementation
2) Priority Project: U.T.Zone 2	122,710	1,604	2002 – 2015
1st stage: Zone 2-1	69,328	1,024	2002 – 2005
2nd stage: Zone 2-2	53,382	580	2010 – 2015
2) Middle-term Projects	149,711	1,960	2003 – 2010
3) Long-term Projects	212,655	2,376	2009 – 2020
4) Postponed Long-term Projects	220,062	2,592	2016 – 2025
Total	704,138	7,466	2002 - 2025

6.3.4 Improvement of Septage Collection and Disposal

(1) Need for improving septage collection and disposal

The amounts of septage that require collection and disposal in the future will depend on:

- how sewerage development proceeds over the planning period and
- how frequently septic tanks are cleaned

Sewerage development is proposed in three urban areas within the Environmental Master Planning area as shown in the following table:

Sewerage Development Targets in Urban Areas

Area	Environmental Zone	Pop. Connected To Sewer		
		2005	2010	2020
1. Nhue River Basin	Tay Ho	25%	60%	97%
	Old City Center			
	Red River Right Bank, N/W and South			
2. Gia Lam	Urban Gia Lam	0%	0%	100%
	(Yen Vien Town)			
3. Dong Anh	Phuong Trach center	40%	49%	49%
	Coa Loa – Red River center			
	Urban area (others)			

Note: Sub-urban zones with densities lower than 30 p.p.ha. are excluded from %

The sewerage development trends for the total study area are depicted in Figure 6.3.11. According to the proposed sewerage plan there will still be a large percentage of the population using septic tanks well beyond the year 2010. Improvements in sewerage will therefore need to be accompanied by corresponding improvements in septage collection and treatment facilities to

prevent environmental degradation, sewer maintenance problems and potential health hazards from the indiscriminant disposal of septage.

The quantity of septage collected from septic tanks and vault toilets must be estimated in order to plan for collection and treatment infrastructure. The quantities of septage will depend mainly on the number of tanks in service, the cleaning frequency, and the size of the tank. The collection of the parameters required to accurately estimate septage quantities was beyond the scope of this study. However for planning purposes it is necessary to establish future trends

The calculation method used to estimate septage quantities in urban areas requiring collection and treatment is described in Fig. 6.3.15. The estimates are based on the following simplifying assumptions:

- one septic tank (or vault latrine) system serves on average about 8 persons on average. The average is higher than the number of people per household to allow for larger installations serving apartment buildings, hospitals, commercial and institutional buildings.
- vault latrines are counted as septic tanks. Although they require more frequent cleaning their number is small therefore their contribution to the daily amount of septage waste is relatively insignificant.
- solids are removed when tanks are ¾ full.
- septic tanks are removed when households are connected to sewers. If tanks are not taken out of service the amount of septage that must be collected will increase significantly despite the implementation of public sewerage systems.

An estimate of septage quantities based on projected sewerage development is presented in Table 6.3.8 and summarized below:

Urban Populations with on-site sanitation systems

YEAR	Nhue River Basin		Gia Lam		Don Anh	
	Pop. (000's)	m^3/d	Pop. (000's)	m^3/d	Pop. (000's)	m^3/d
1997	1,344	343	129	33	114	29
2005	1,008	257	144	36	140	36
2010	532	136	153	39	160	41
2020	40	10	0	0	342	87

Note: Sub-urban zones with densities lower than 30 p.p.ha. are excluded

URENCO collects about 75 m^3/day which is relatively small compared to the estimated amounts if tanks are cleaned when ¾ full. The low collection amount can be caused by a number of factors:

- very few septic tanks are maintained properly

- the private sector is actively involved in collection and disposal
- private sector services are more affordable than URENCO services.

(2) Options for the treatment and disposal of Septage

The principal methods most commonly used for the treatment and disposal of septage are as follows:

- Land application
- Co-disposal with solid wastes
  - land filling with solid waste
  - composting with solid waste
- Co-treatment with wastewater
  - biological treatment
- Processing at separate facilities including:
  - Aqua culture
  - biological treatment
  - lime stabilization
  - composting

1) Land Application

Septage can be applied in liquid form directly to the surface of the land with spray guns, trucks equipped with liquid spreaders, and liquid manure spreaders used on farms. Spreading should be followed by a short drying period and then disking to incorporate the dried sludge into the soil.

Septage can also be dewatered in lagoons or on drying beds and applied directly to land in a solid or semi-solid form. High annual rainfall in makes the use of sludge drying beds in Hanoi impractical.

Most of the problems associated with surface application can be overcome by subsurface application. The methods most commonly used for subsurface application of septage are: i) the furrow cover method in which septage is applied in narrow furrows and covered with soil by a following plow, and ii) the injection method in which septage is injected in a wide band or several narrow bands 150mm below the surface of the soil. Subject to loading limitations, land application can provide effective treatment and disposal of soil.

In the Study area, the use of septage as fertilizer is widespread in low population density areas. Land application of septage from is considered

sustainable for all sub-urban settlements in areas with densities of less than 30 persons per hectar.

For Hanoi City and surrounding urban developments the daily quantities are large. The principal concerns associated with direct application of septage on land are the potential health risks, the possible contamination of groundwater, and the production of nuisance conditions and odors.

2) Co-disposal with solid waste

In the past, most of the septage collected by URENCO was disposed of at the landfill site. The landfill site must be sealed properly to eliminate contamination of the underlying groundwater. The landfill site at Nam Son is not designed for gas production and recovery, therefore, the application of septage would lead to anaerobic decomposition and the undesirable production of gas (methane). Therefore, co-disposal of septage with solid wastes at the landfill site is not feasible.

Septage solids can be co-composted with solid wastes to produce humus-like end product. Composting is the biological decomposition of the organic matter in the septage and solid waste (paper) in the presence of oxygen under thermophilic (49 to 57 ^{0}C) dewatered conditions. Composting of municipal solid waste is often used to process the waste into a soil conditioner for agricultural purposes. Analysis of the nutrients in the waste was not performed in this study, however, ranges of nutrients commonly found in solid waste compost are:

Ranges of Nutrients

Nitrogen	0.5% to 3%
Phosphorous	1% to 2%
Potassium	1% to 2%

As such, solid waste compost does not lend itself to being marketed as a fertilizer substitute. Adding nutrients by septage sludge is a method that could improve the fertilizer value and marketability of the compost.

At present, URENCO applies septage directly to composting piles at Cau Dien. While composting solid waste with septage can provide a much more valuable final product, a proper mix of solid waste and septage must be maintained. The ratio of solid waste to septage that will compost properly is usually 1:1 by weight when septage is applied in liquid form with about 5% solids. Co-composting can only be used effectively if solids contents of the

septage are high. Thus it is usually only used for further treatment of the solids separated from the septage by drying or dewatering process.

The present composting process is ineffective mainly because the waste stream is not properly sorted to remove glass, metals and plastics which interfere with composting. URENCO will be building a new composting facility in the near future with the help of foreign ODA. The facility may be able to process up to 50,000 tons of solid waste per year. Therefore, if 137 tons per day of solid waste are composted then 137 tons (or 137 m^3) of septage with 5% solids can in theory be added to it. The success of processing septage at the composting facility will affected by many variables which are impossible to predict:

- the quality of the solid waste
- the quality of the septage
- the proper operations of the composting process.

In order to properly assess the composting process and its capacity for treating septage a pilot study is recommended. Due to the cost of even the smallest mechanized operation, it is recommended that a manually operated, small-scale composting plant be developed before implementing the full scale composting facility proposed by URENCO.

3) Co-treatment with wastewater

Co-treatment with wastewater at a local wastewater treatment plant is usually one of the most cost-effective methods for the treatment and disposal of septage. Since new wastewater treatment plants are proposed by the wastewater master plan the option of co-treatment of septage with wastewater appears to be the most practical and logical way for septage disposal. However, because septage has higher BOD and SS loads than wastewater, the treatment plants will need sufficient excess capacity and solids handling capability to process septage.

4) Separate septage treatment facilities

If wastewater treatment plants are not available, consideration must be given to the construction of facilities specifically designed for the purpose of septage treatment and disposal. Septage processing at specially designed facilities can be accomplished by : a) biological treatment, or combined physical and biological treatment, b) lime stabilization and c) chemical oxidation. One of the major problems associated with the processing of septage at separate facilities is that some method must be found for the

disposal of the liquid and solid portions of the septage after treatment. Discharge of the liquid portion to receiving water body must meet the Vietnamese Standards for Industrial Effluent.

(a) Biological treatment:

The biological treatment of septage is usually accomplished in : i) either aerobic or facultative (anaerobic/aerobic) waste stabilization ponds, ii) conventional biological treatment facilities, and iii) combined physical and biological treatment facilities.

Where climatic conditions are favorable and land is readily available, waste stabilization ponds can be a cost-effective way to treat wastewater and can also be designed to receive solely septage. A typical flow diagram is shown in Figure 6.3.12

Aerobic lagoons are shallow (0.3 to 0.9 m) impoundments into which septage is discharged. Oxygen is supplied by the photosynthesis of algae. Facultative ponds provide aerobic stabilization of waste in the surface layers and anaerobic digestion in the lower layers. Facultative ponds are usually 1.2 to 2 m deep. Typically at least two lagoons are used so that one can be dewatered and dried for solids removal. The dried solids can be disposed of at the landfill site or spread on land. Pond effluent can be disposed of i) in infiltration beds, ii) by evaporation, iii) by further treatment in maturation ponds and constructed wetlands before using in irrigation to remove risk of pathogens. Facultative ponds can in some cases lead to nuisance problems such as odors and should be sited away from population centers.

Where discharge requirements for nitrogen and phosphorus are quite low, the treatment of septage is accomplished using more process intensive facilities such as shown in Figure 6.3.13.

(b) Lime stabilization:

In the lime stabilization process, lime is added to destroy pathogenic organisms. For the process to be effective the pH must be raised to a value of 12 or greater for at least 30 minutes. After lime treatment the solids must be removed. The liquids and the solids must be disposed of separately. Because of the number of treatment steps involved in the process and the cost of chemicals, this process is not often used on a long-term basis. However, lime stabilization can be used to deal with short-term septage disposal problems.

c) Chemical oxidation

The most common chemical oxidation process involves the use of chlorine gas for stabilization of the septage. Because of the cost and complexity of this and other similar processes, chemical oxidation is not used extensively for the treatment of septage and is not recommended.

d) Comparison of treatment options and recommendations

A qualitative comparison of options is presented in the following table in order to which methods are likely to be the most practical or feasible for the situation in Hanoi. Based on the evaluation of advantages and disadvantages there are two possible options:

- Co-treatment of septage with wastewater at sewage treatment plants and
- Treatment of septage at waste stabilization ponds designed to receive septage only.

Comparison of Septage Treatment and Disposal Options

DISPOSAL METHOD	ADVANTAGES	DISADVANTAGES	FEASIBILITY
Surface application	• no treatment required • inexpensive	• potential health risks • groundwater and surface water contamination • nuisance odors	Large scale application is rejected because of potential environmental and health risks. Feasible only for small scale use in rural areas.
Landfill	• convenient • no need for separate disposal site or treatment	• potential groundwater contamination • formation of methane in the landfill	Rejected because of the negative impacts on landfill operations.
Compost	• potential for beneficial re-use of end product	• septage must be de-watered to increase solids content • de-watering is expensive • disposal cost for composted septage outweigh the economic benefits	Requires pilot study to determine feasibility. The existing process is ineffective and quality of compost is poor making it unusable.
Co-treat with wastewater	• cost effective where treatment plants have excess capacity	• excess treatment capacity is required for high BOD and SS of septage to prevent treatment plant upsets • creates more sludge that must be disposed	Recommended as the most cost-effective solution since treatment plants will be constructed for wastewater.
Separate conventional biological treatment	• high level of treatment	• expensive • same treatment can be provided at wastewater treatment facilities	Rejected because it is too expensive as an interim solution.

DISPOSAL METHOD	ADVANTAGES	DISADVANTAGES	FEASIBILITY
Waste stabilization ponds	• inexpensive operation and maintenance • simple technology easy to operate • Efficient treatment levels and reduction of pathogens and helminth eggs.	• higher land requirements • potential odor problems	Recommended as interim solution until wastewater treatment plants become available
Lime stabilization	• effective destruction of pathogenic organisms • simple treatment process	• septage must be de-watered • water and solids must then be treated separately • chemical intensive, therefore high cost	Rejected because it is expensive and increases the amount of solids that must be disposed.
Chemical oxidation	• effective treatment	• expensive • complex	Rejected because it is very expensive and complex

(3) Master Plan for improving septage collection and disposal

The needs for septage collection and treatment infrastructure will vary over time and will be different in each environmental zone and each of the three main urban development zones of Hanoi City, Gia Lam and Don Anh.

Master planning focuses on urban areas since the quantities of septage generated by urban developments are relatively large and concentrated, and high population densities make it impractical for residents to dispose of septage in an environmentally sustainable way.

In suburban areas with population densities of less than 30 persons per hectare a variety of sustainable disposal options already in practice are feasible at these low densities therefore suburban areas are excluded from future septage estimates and planning for disposal infrastructure. The following assumptions are adopted in developing a plan for future septage collection and disposal:

- Cleaning of septic tanks will be on a regular basis
- Domestic septage will be co-treated at wastewater treatment plants where possible
- Collection capacity will not exceed capacity to properly treat septage.

Projected infrastructure needs are based on the following estimated quantities of septage and collection targets (assuming a four-year cleaning cycle).

Future Septage Quantities and Collection Targets

YEAR	NHUE RIVER BASIN			GIA LAM			DON ANH		
	Produced m^3/d	Collected m^3/d	% of total	Produced m^3/d	Collected m^3/d	% of total	Produced m^3/d	Collected m^3/d	% of total
1999	343	75	22%	33	5	15%	29	2	5%
2005	257	175	62%	37	20	54%	36	16	45%
2010	136	130	96%	39	27	69%	41	33	80%
2020	10	9.5	95%	0	-	-	87	83	95%

Note: Suburban zones with densities lower than 30 p.p.ha. are excluded

The transition of planned septage collection and sewerage population for each environmental zone is illustrated in Figure 6.3.14. Environmental Zone 1 and Zone 7 (Old City Center and West Lake) show a very rapid decrease in the number of people connected to septic tanks as a result of extensive sewerage development between 2000 and 2010. Environmental zones 2, 3 and 5 (Red River Right Bank North West, South and Gia Lam show little change until 2010 followed by a rapid decline in the number of septic tank systems between 2010 and 2020. Despite sewerage development, environmental zone 4 (Dong Anh) shows an increase in the population using septic tanks because of the rapid urban growth. Environmental Zone 6, which represents suburbs in different geographical locations, has no planned sewerage development therefore the number of people using septic tanks is proportional to the future population growth.

1) Hanoi City (Nhue River Basin)

In Hanoi City the ongoing development of sewerage systems will, in the long-term, result in a steady reduction in the number of septic tanks and thus the amount of septage requiring disposal. Nevertheless, the quantities of septage will remain significant well past the year 2010, especially if regulations requiring cleaning are enforced. Therefore the capacity to collect and treat septage must be improved. The plan for improving septage collection and disposal is presented in Table 6.3.9 and described in the following paragraphs.

(a) Short-term 2000 - 2005

In the short term the quantities of septage collected in the City of Hanoi will be significant. An interim disposal solution is required since URENCO only has a small capacity for co-treatment of septage at the solid waste composting plant. In the interim it is proposed that septage from Hanoi be sent to a suitable and properly managed waste stabilization pond to be constructed in Gia Lam.

Improvements in septage collection capacity should only occur if proper treatment and disposal facilities are developed. Therefore, in the short-term it is recommended that there be no increase in the amount of septage collected in Hanoi until the treatment facility is constructed in Gia Lam. However, since existing septage pumping trucks are very old they should be replaced more powerful modern vacuum trucks.

(b) Mid-term 2006 - 2010

The first wastewater treatment plant in Hanoi will be in operation by end of 2005 to serve the existing sewered area of the old city center. It is recommended that septage be co-treated at this wastewater treatment plant once the treatment process reaches a stable operating regime. By 2008 a second treatment plant will be available in Hanoi for the co-treatment of septage with wastewater.

With the advent of wastewater treatment plants the amount of septage that is collected can be increased in order to provide BOD loading on receiving waters. A pricing strategy should be implemented at this stage to encourage the regular pumping of septic tanks. The total amount of septage collected will thus depend on the affordability of the service and the willingness of households to use the public service.

By 2010, mandatory-cleaning regulations should be implemented and enforced. The cost of service can be successfully recouped by charging a flat rate to all residents. A flat rate also has the positive effect of simplifying enforcement since cleaning will no longer be at the discretion of individual households but provided as a public service to all residents.

(c) Long-term 2011 - 2020

Two more wastewater treatment plants capable of co-treating septage will be put into operation in 2012 and 2015. By this time the amount of septage requiring disposal will begin to decrease as more people are connected to sewer systems. By 2020 sewerage development covers 97% of the urban population and the amounts of septage will have been significantly reduced.

2) Gia Lam

In Gia Lam the development of sewerage systems will not take place until the later part of the planning period. Although the number of septic tank systems in urban areas will increase steadily, the quantities of septage will remain relatively low throughout the planning period. By the year 2020 sewerage

systems will serve all households and septage will be reduced to a very small quantity. The plan for improving septage collection and disposal is presented in Table 6.3.10 and described in the following paragraphs.

(a) Short-term 2000 - 2005

Sewage treatment plants will only be available by 2020 therefore separate septage treatment facilities will be required. It is recommended that septage treatment ponds be constructed near Gia Lam, strategically located to minimize travel distances to the planned urban development zones. A location near Dong Du has been identified as a potential site for the future wastewater treatment plant. The location is ideal for waste stabilization ponds because there is an abundance of lakes and natural ponds already in the area to provide dilution water and effluent disposal.

Septage from Hanoi will be disposed at the Gia Lam ponds until 2005 when the first wastewater treatment facility becomes available.

At present, septage amounts are small and there is no urgent need to improve collection capacity in Gia Lam. In the short term, until a septage treatment facility is constructed, septage could be disposed of at the Kieu Ky landfill site as long as measures are implemented to control surface and groundwater contamination and proper daily cover is provided.

(b) Mid-term 2006 - 2010

A separate septage treatment and disposal facility should be in operation by this time. The amount of septage requiring disposal will have increased since urban development will proceed without the implementation of sewerage systems. The septage collection capacity will need to be improved.

(c) Long-term 2011 – 2020

Wastewater treatment plants will be operational around 2020 and septage can then be co-treated with wastewater. The waste stabilization ponds can be abandoned or if there is a need it can be used for the disposal of septage from surrounding sub-urban areas where small pockets with higher population densities may make disposal of septage to surrounding land areas impractical or undesirable.

3) Don Anh

In Don Anh, development of urban communities is closely linked to the development of industrial zones. Master planning indicates that wastewater

treatment systems for urban communities surrounding industrial zones will be provided as part of the requirements for developing nearby industrial parks. Therefore, Don Anh will be characterized by a large number of small-scale community based treatment systems in urban areas clustered around industrial zones. These community systems will serve an estimated 50% of the urban population by 2020. The plan for improving septage collection and disposal is presented in Table 6.3.11 and described in the following paragraphs.

(a) Short-term 2000 – 2005

The quantity of septage is at present insignificant and not expected to increase in the short term. Collection and disposal is community based and septage is re-used in a sustainable way at a number of small sites scattered around the rural areas.

(b) Mid-term 2006 - 2010

Industrial zones will begin to develop and populations in the urban communities surrounding them will increase. Each community will be responsible for wastewater management and disposal of septage. A number of small-scale community wastewater treatment plants will be constructed and these may be used to co-treat septage if they are properly designed. Alternatively, septage can be transported to the septage disposal ponds proposed in Gia Lam district.

c) Long-term 2011 - 2020

Rapid urban growth triggered by the development of industries will result in a significant increase in the number of small-scale community systems septic tanks in service. Urban development will occur in a number of zones clustered around industrial development as well as in two major centers: the Co Loa – Red River Center and Phuong Trach Center. Septage can be treated at the wastewater treatment plants constructed to serve the main population centers.

(4) Facilities required for co-treating septage at future wastewater treatment plants in Hanoi City

Data on the characteristics of septage are not available but they will be required to design septage treatment and disposal facilities in the future. The typical value of important parameters are provided in the following table:

Characteristics of Septage

Constituent	Concentration, mg/l Range	Typical	Unit Loading, kg/capita day Range	Typical
BOD5	2,000 – 30,000	6,000	0.005 - 0.013	0.009
TS	4,000 – 100,000	40,000		
SS	2,000 – 100,000	15,000	0.009 - 0.045	0.022
VSS	1,200 – 14,000	7,500		
TKN	100 – 1,600	700		
NH3	100 -800	400		
TP	50 - 800	250		
Grease	5,000 – 10,000	8,000		
Heavy metals [a]	100 – 1,000	300		

A= primarily iron, zinc and aluminum.

There is a wide range in values, therefore, septage must be carefully characterized by a sampling program before proceeding with facility design. The impact of septage on the proposed wastewater treatment plants is quantified in calculations presented in Table 6.3.12. The main problem is usually organic overloading and suspended solids that exceed plant handling capacity. As shown in the calculations, in the year 2005, septage will represent a significant increase in loads on the proposed zone 2-1 treatment plant. Therefore, the treatment plant will need to be designed with sufficient capacity to treat organic loads and suspended solids.

The wastewater treatment plants can easily be designed with excess treatment capacity for the liquid portion of the septage. Problems of organic overloading can be overcome by collecting and storing the septage during the daytime hours and then discharging it slowly to the treatment plant in the early morning hours or when incoming organic and solids loading to the plant are at the lowest. Solids loading is a more serious problem. Pre-treatment facilities will need extra solids processing capacity to accept the higher solids contents typical of septage. Loading will be within normal ranges once a second treatment plant becomes operational in 2008.

It will be necessary to construct a septage receiving facility at each treatment plant. Typically, as shown in Figure 6.3.17, a septage receiving facility will consist of an unloading area, a septage storage tank, and at least two or more grinder type transfer pumps. The storage tank is used to store the septage so it can be released to the treatment process in a controlled fashion. The storage tank should be covered and ventilated for odor control.

Discharge to the headworks is usually preferred so the septage can receive preliminary treatment for the removal of grit and screenings. If the septage is especially strong it should be diluted with wastewater. In some cases additional dilution may be required and can be obtained by using re-using treated effluent.

Investment cost estimates for the treatment plants are increased by 1% to allow for the excess treatment capacity required for co-treating septage waste and the septage receiving facility. Operating costs are increased by 15% to allow for the extra energy and chemical costs required for treating over strength septic waste.

(5) Waste stabilization pond facilities

Process design for waste stabilization ponds is the same as for ordinary waste stabilization ponds except a higher BOD value of 6,000 mg/l is used for septage. Septage ponds differ from normal waste stabilization ponds in their physical design and operation. The inlet to the facultative ponds requires a chute into which the tanker trucks can discharge their load. In order to prevent sludge from accumulating several chutes are normally provided and these are used in rotation. It is also sensible to add dilution water while the septage is being unloaded to facilitate processing and dispersion throughout the pond.

Waste stabilization ponds should be located near a river or drainage canal so that water can be used to wash out the tankers, wash down the concrete apron around the inlet chutes, and to provide sufficient flow to balance evaporative losses.

Typically the treatment process is divided into two or more parallel streams so that one pond can be taken out of service for solids removal typically at 15-year intervals. A flow schematic showing the typical waste stabilization pond arrangement is shown in Figure 6.3.16.

Preliminary calculations for determining land requirements are provided in Table 6.3.13. The initial pond area required for treating septage from Hanoi, Gia Lam and Dong Anh is approximately 8 ha. The pond area can be reduced by about half when septage from Hanoi is co-treated with wastewater at newly constructed treatment plants. The level of treatment required will depend on the effluent standards for the receiving water body. The following Vietnamese Standard for industrial effluent (category B) will be applicable if the ponds discharge effluent to a water body used for irrigation or aquaculture:

Effluent Standards

Constituent	Concentration, mg/l
BOD5	50
SS	100
TKN	60
Ammonia nitrogen	1
TP	6

The use of stabilization ponds alone cannot achieve the limits for nitrogen and phosphorous removal, therefore, additional treatment will be required. The use of a constructed wetland is recommended and has proven to be effective in treating final effluent to remove nutrients.

(6) Management of septage in Nhue River Basin and Gia Lam

Wastewater management, which is the responsibility of TUPWS and HSDC, has consisted mainly of cleaning sewers and drains to prevent flooding. With the introduction of wastewater treatment systems both organizations will begin to play a more important role in managing the impacts of wastewater on the environment. They must ensure that treatment systems provide the benefits they were designed to achieve.

The sewerage plan identifies several urban areas where on-site and community systems will be in use. These systems require very little maintenance but they rarely get any. As a result, many systems fail and create problems in high density urban areas such as odor nuisance, silting of sewers, environmental degradation and in some cases a public health problem. To ensure that onsite and community systems function properly it is usually necessary to give management responsibility to a public sector authority.

HSDC will ultimately be responsible for wastewater treatment and co-treatment of septage at wastewater treatment plants. It would, therefore, simplify coordination and planning if HSDC was also responsible for the collection of septage and maintenance of community and on-site systems. Therefore, it is recommended that TUPWS transfer management responsibility, staff and equipment for septage collection from URENCO to HSDC. The benefits of integrating septage with wastewater management within one authority include:

- Control over scheduling and impact of discharges on treatment plant processes and ultimately effluent quality
- Control over the type of waste that is collected and disposed (domestic waste only and not industrial liquid/sludge wastes)
- Better understanding of future sewerage development needs and priorities since collecting septage will allow HSDC to become more familiar with location of systems, and types of problems.
- Collecting septage from households will provide HSDC with an opportunity to collect information useful for planning such as: inventory of sewer connections, type of service (residential, commercial, high density, low density), size of septic tanks, frequency of maintenance and characteristics regarding sewer use

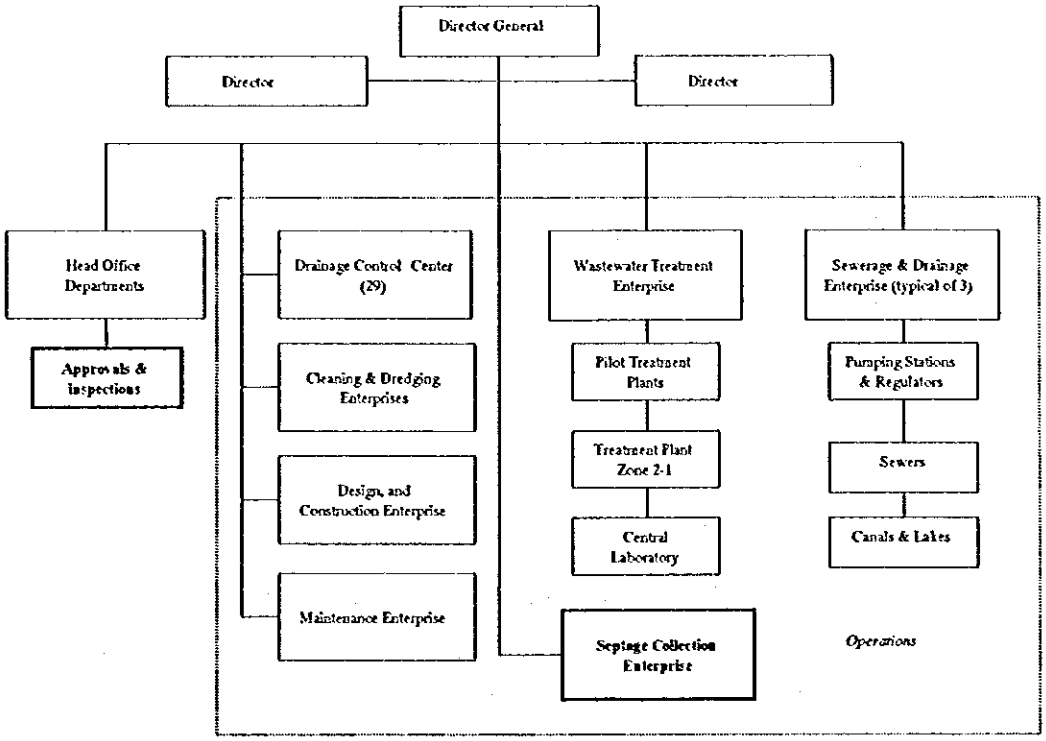
and flows in various tributary areas.

The transfer of responsibility to HSDC for septage collection and disposal in Hanoi City should occur before the construction of the wastewater treatment plants. An early transfer is preferable because it would provide sufficient lead-time for HSDC to collect the data on sewer use required to support the design of wastewater collection and treatment systems. Ample lead-time will also be required for HSDC to become familiar with scheduling septage collection operations to minimize potential impacts on treatment systems.

HSDC will need to assume a new range of responsibilities for the proper management of septage and wastewater services:

- approval of design and construction inspection for on-site and community systems
- design and construction standards for on-site and community systems
- annual or semi-annual inspection of community and on-site systems
- issuance of permits to operate, failed system citations, and abatement orders
- scheduling septic tanks maintenance

It is recommended that HSDC create an approvals and inspection section within the engineering department to carry out the above tasks. Septage collection operations will be the responsibility of a new Septage Collection Enterprise transferred from URENCO with staff and equipment. The recommended organizational structure is shown below:



HSDC - Organizational Structure for Septage Collection: 2005

1) Personnel

Staffing requirements will include drivers, laborers and mechanics for collection vehicles, engineers for planning, approval and construction of on-site and community systems, inspectors to issue permits, and monitor compliance.

The new approval and inspection section will coordinate its activities closely with the collection enterprise. Staffing levels in the approvals and inspection section should be sufficiently high in the initial stages to accelerate the inspection of several thousand septic tanks and collection of data required for sewerage planning. Over time, as maintenance improves and the number of systems decreases, the number of people required can be reduced.

Incremental staffing levels, investment and operating costs for implementing the priority project for Hanoi City (excluding collection in Gia Lam and Dong Anh) are presented for each year of the planning period in Table 6.3.14. Annual program costs are summarized as follows:

DIVISION/ PROGRAM	2000-2005	2006-2010	2011- 2020
Collection and treatment (no.of staff at end of period)	22	18	0
Approvals and inspection program (no. of staff at end of period)	10	20	35
Collection vehicles	22	14	0
Total Investment costs * (000's USD)	10,763	1,944	0
Annual Operating costs** (000's USD)	11.5	11.9	11.9

* Investment costs are total capital costs for the period including equipment replacement.

** Annual operating costs are for the last year of the period indicated.

2) Financial implications of master plan for whole Study area

The main costs over the planning period will include: salary for staff, investment for vehicles and facilities, incremental costs for operation at wastewater treatment plants caused by treating extra strength waste. Funding for staff and recurring O&M costs will come from the state budget. Investment funding will come from official development assistance.

A schedule of investment and operating costs for implementing septage collection and disposal in urban areas over the whole Study area is presented in Table 6.3.15. These cost projections are generated for the purposes of evaluating the financial viability of the EMP from 2000 to 2020.

(7) Priority Project for the Construction of a Septage Disposal Facility and Supply of collection vehicles

1) Necessity

In Hanoi almost every household or commercial building has a septic tank. Tanks are cleaned infrequently resulting in high organic loads to sewers, drains and receiving waters. URENCO collects about 75 m^3/d of septage and nightsoil from urban areas within the City of Hanoi. Disposal at the Cau Dien composting facility is ineffective because quantities exceed processing capacity and the composting process itself is not operated properly.

Disposal problems are expected to get worse in the very near future because the proposed new composting facility will only be able to process approximately 10 m^3 day of septage. Disposal of septage at the new Nam Son landfill site is not technically feasible, therefore, an interim disposal solution is

required for domestic septage in the short term.

In Gia Lam, rapid population growth by the year 2005 and the absence of sewerage infrastructure until late in the planning period will create the need for septage facilities.

Septage vehicles operated by URENCO are more than 10 years old. The trucks do not provide sufficient suction power to reach septic tanks located behind houses and in long narrow alleys where trucks cannot access.

2) Outline of the project

Existing septage collection trucks need to be replaced with a smaller number of new vacuum trucks that can provide better service. Approximately 22 vehicles are required between 2000 and 2005.

Based on the preliminary assessment carried out in this Study it is recommended that a waste stabilization pond facility be constructed in Gia Lam to treat domestic septage from Hanoi and Gia Lam urban areas. Approximately 7 hectare of facultative pond surface area is required plus an additional 3 ha for wetlands or aquatic treatment system to remove nutrients from the effluent. A potential site has been identified in Don Du south of Gia Lam for the future wastwater treatment plant. This site or another nearby site would be ideal for septage treatment ponds because there is an abundance of surface water and natural drainage to the Red River.

It is expected that the disposal facility will receive domestic septage from Hanoi until 2006 when the first wastewater treatment plant becomes available for the co-treatment of septage. Should the availability of the treatment plant be delayed, the interim disposal facility can continue to provide treatment of septage.

While the operation of waste stabilization ponds is relatively simple the facilities must be properly designed to mitigate the potentially harmful environmental impacts of septage. Therefore, prior to the design and construction it is recommended that a feasibility study be carried out to determine among other things:

- other potential sites for septage disposal ponds,
- availability of transportation routes and proximity of sites to collection areas
- optimum number of disposal sites
- selection of preferred location
- site topographic survey,

- the surface drainage characteristics of the site,
- bore holes to determine geological characteristics, and groundwater regime
- sampling of septage from typical households, hotels, commercial and institutional buildings, to determine strength and establish typical quantities
- sampling of water quality in any receiving streams,
- environmental impact assessment
- detailed design
- cost estimates

3) Implementation

TUPWS should be responsible for the preparation and implementation of the project. Presently, URENCO is responsible for collection of septage and disposal at the composting plant. HSDC should in the near future become the executing agency for septage collection and treatment in Hanoi and Gia Lam. Therefore, counterparts from both agencies should be involved in the study to effect a smooth transfer in management responsibility.

The feasibility study should take no more than one year to complete. Detailed design, tendering and construction should follow shortly after the feasibility study and take no more than two years.

Implementation and Disbursement Schedule

Schedule	2000	2001	2002	2003	Total
Feasibility study					
Design, Tender/award					
Construction/procurement					
Operation					
Investment cost (000's USD)	4706	836	4180	486	10,208

(8) Introduction of Public Toilet as Part of Septage Collection System

As explained in the previous sections, septage collection and disposal was planned for the entire Study area not served by sewer system. According to the proposed sewerage plan, there will still be a large percentage of the population using septic tanks well beyond the year 2020. In the septage collection plan, it is assumed that all of the populations not served by the sewer system have access to septic tank. The estimated such population is around 400,000 in year 2020 (Table 6.3.8). However, in reality not all persons can have access to septic tank of their own. The actual present condition of on-site sanitation in Hanoi can be hardly known, as the

on-site sanitation condition has not been formally investigated. However, it can be said that suitable septic tanks have not been spread widely in Hanoi since a design standard of septic tank is not available. Also there is no regulation to enforce mandatory construction of septic tank for each household.

It is recommended to have legislation enforcing construction of septic tank in each household and adopt standard septic tank design to improve the urban environment. However, even after having such legislation, rapid implementation may not be possible due to various reasons, especially on the part of low-income family.

To provide 100% sanitation access, it is therefore required to provide public toilets. Also, public toilet should be provided in the commercial centers to render basic amenities for the moving persons.

Public toilets should be constructed in low-income localities and in places of public gatherings. It would be better to have multiple toilets in one structure to make operation and maintenance easy. These should operate round the clock and at least one attendant should be present at in each location. To cover the operation cost, a token user fee can also be collected. Another alternative is to lease the facility to private sector to operate.

Public toilet should be pour flush type with water seal to have maximum sanitation benefit. It should be connected with the sewer line if available. Otherwise, a septic tank should be constructed with regular septage removal. It is always better to have water supply for cleaning facilities.

6.3.5 Improvement of Lakes/Ponds Water Environment

Lakes, ponds, and channels are used to collect and drain wastewater and storm water. However, the city's lakes/ponds, especially in the urban area, cannot function as drainage and purification facilities since the lakes/ponds are overloaded by organic waste and nutrients and the bottom layers and sediment are anaerobic. The ecological capacity of the city's waters become worse and is reduced, and so the polluted surface water in the city should be prevented by developing properly the utilization of the ecological capacity.

The primary requirement for improving lakes/ponds water quality is to reduce the inflow of pollution loads transported by wastewater. As well, the following are contemplated as subsidiary measures:

- Temporal shut-off of dry season wastewater inflow by providing a diversion basin,
- Aeration facilities, including aerator, fountain and diffused aeration devices,
- Provision of a settling basin if possible, with screens used to shut-off inflow of

floating particles,

- Dredging of sludge/sediment.

Targeted lakes for improvement are proposed as shown in Figure 6.2.2. Total construction cost of the lake conservation project consisting of three projects: the West Lake, the main city lakes and the other city lakes is estimated at US$ 47 million as presented in Table 6.3.16. Implementation schedule of the lake conservation projects is planned as given in Figure 6.3.9 and the proposed projects are described below according to each target year of environmental improvement:

(1) Short-term measures: by 2005

1) Priority projects

The two projects of the West Lake water quality improvement and the main City lakes improvement covering covering the Environmental Zones: Ho Tay Area and Old City Center are selected for the priority projects.

(a) West Lake Water Quality Improvement Project

West Lake, which is the largest water body in the study area (its lake surface is approximately 5.1 km^2), has the most potential in terms of water environment improvement. Presently, the lake is widely used as one of the most popular recreational spots in the city of Hanoi. Hence, several projects can be expected to enhance the water environment, such as lake shore road/park project, sewerage development project and lake sediment dredging project.

At present, HPC is undertaking the Phase I: Infrastructure Project of the West Lake Conservation Project including lakeshore road/park and small-scale sewerage developments. The outline of the selected West Lake Water Quality Improvement Project is presented below and the project is executed under Austria Aid as the Phase II of the West Lake Conservation Project as shown in Figure 6.3.9.

- Lakeshore dredging work to create a long term effect on tourism, recreation, and fishing, (on account of its large water area),
- Flushing water introduction of diluting water directly from the Red River to reduce the water quality, particularly the turbidity, of the lake;
- Establishment of the public sewerage system to prevent inflow of wastewater.

(b) Main City Lakes Improvement Project

Main City lakes (14 lakes) located at the Environmental Zone of Old City

Center are improved by the following measures in order to restore functions for storm-water retarding ponds and waterfront resort.

- Lake dredging works for 14 lakes: Than Cong, Tho Quang, Trung Tu, Bay Mau, Nahia Do 1, Ngoc Khanh, Hao Nam, Phuong Liet 1 & 2, Trai Ca, Lang Tam, Thanh Liet, Dam Set and Van Chuong lakes,
- Lake conservation works for 11 lakes excluding Than Cong, Tho Quang and Bay Mau lakes among the above 14 lakes: by conservation measures such as construction of lakeshore roads and environmental revetments, planting trees, provision for parks and promenades, and other environmental measures.

2) Other short-term measures

The following non-structural measures are required in relation to the comprehensive water management development as mentioned in the sub-section 6.3.3.

a) Care for drainage and sewerage campaign
b) Improvement of solid waste and septage collection system by URENCO
c) Regulations and financial supports for installation of on-site wastewater treatments at factories, enterprises and hospitals

(2) Middle-term and long-term measures: By 2010 and 2020

A fundamental solution to worsening water quality of about 50 lakes in the Environmental Zones of Old City Center, Red River Right Bank North West and South can be achieved by preventing wastewater inflow from the souses. This could be done by constructing wastewater treatment plants and collection system. However, this construction would be very expensive and quite long term. Therefore, to temporarily improve water quality in the environmental zones, at crucial stage due to heavy urbanization, by the time of completion of wastewater disposal system, the following improvement measures for the 50 lakes are proposed:

- Temporal shut-off of dry season wastewater inflow by providing a diversion basin,
- Aeration facilities, including aerator, fountain and diffused aeration devices,
- Provision of a settling basin if possible, with screens used to shut-off inflow of floating particles,
- Dredging of sludge/sediment,
- Lakeshore line conservation for protecting surface water area.

In order to improve the waterfront environment, this project will be carried out during 2008 and 2015.

(3) Project cost estimate and implementation schedule

Project cost of the public sewerage projects is estimated as shown in Table 6.3.16 under the following conditions of cost estimate:

a) Adoption of unit prices in Vietnam at the place level of 1999

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

Figure 6.3.10 indicates the disbursement schedule at each drainage projects according to the recommended implementation schedule as shown in Figure 6.3.9. The cost of the urban drainage project and annual O&M cost are summarized below:

The cost of the urban drainage project and annual O&M cost

(Unit: US$1,000)

Lake Conservation Project	Project Cost	Annual O&M Cost	Implementation
3) Priority Project	46,679	277	2001 – 2005
West Lake Water Improvement	36,421	266	2001 – 2003
Main City Lakes Improvement	10,258	11	2002 – 2005
2) Middle/ Long-term Projects	22,176	90	2008 – 2015
Total	68,855	367	2001 - 2015