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Socialist Republic of Vietnam

Performance of the Wastewater Sector in Urban Areas: A Review and Recommendations for Improvement

Vietnam Urban Wastewater Review

December 2013

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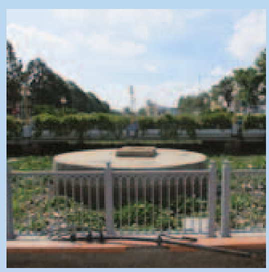
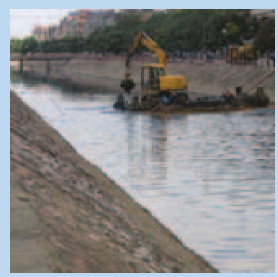
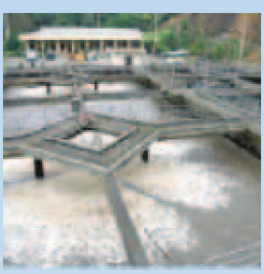
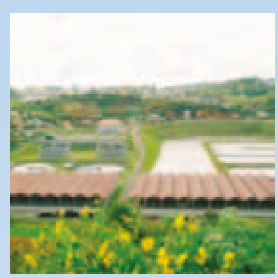
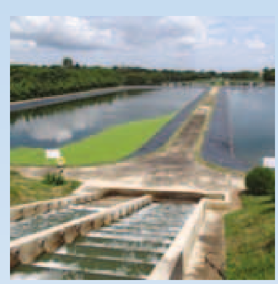
Vietnam Urban Wastewater Review



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This Vietnam Urban Wastewater Review has been prepared by the Task Team consisting of Lê Duy Hưng (Senior Urban Specialist, Sustainable Development Unit in Vietnam [EASVS], Team Leader), Alan Coulthart (Lead Municipal Engineer, Infrastructure Unit, East Asia and the Pacific Region [EASIN], Co-Task Team Leader from March 2012 to June 2012), Sudipto Sarkar (Sector Leader, Water and Energy, East Asia and the Pacific Region [EASWE], Co-Task Team Leader from July 2012-present), James Corning (Lead International Consultant from March 2012 to March 2013), Nguyễn Việt Anh (PhD, Associate Professor, National Wastewater Specialist), Trần Việt Nga (PhD, Assistant) and Ross Kearton (Technical Editor). The study has produced two reports, comprising: the Executive Summary, for the decision makers, and the Technical Report for the interested specialists.

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ABBREVIATIONS

ADB	Asian Development Bank
A_2O	Anaerobic-Anoxic-Oxic Wastewater Treatment Technology
AS/ASP/CAS	Conventional Activated Sludge Technology
BOD	Biological Oxygen Demand
CAPEX	Capital Expenditure/Capital Expense
C:N	Carbon to Nitrogen Ratio
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow (Diversion Chamber)
CSS	Combined Sewerage System
DOC	Department of Construction
DOLISA	Department of Labor, Invalids and Social Affairs
DONRE	Department of Natural Resources and Environment
EP	Environmental Protection
EPL	Law on Environmental Protection
ESI	Economics of Sanitation Initiative
FSM	Fecal Sludge (Septage) Management
GDP	Gross Domestic Product
HCMC	Ho Chi Minh City
HSDC	Hanoi Sewerage and Drainage Company
HHs/HHC	Households/Household Connection
IEC	Information, Education and Communication
JICA	Japan International Cooperation Agency
KfW	Kreditstalt für Wiederaufbau
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOF	Ministry of Finance
MOLISA	Ministry of Labor, Invalid and Social Affairs
MONRE	Ministry of Natural Resources and Environment
M&E	Monitoring and Evaluation
MPI	Ministry of Planning and Investment
MPN	Most Probable Number
NTP	National Target Program

OD	Oxidation Ditch Technology
ODA	Official Development Assistance
O&M	Operation and Maintenance
OPEX	Operating Expenditure / Operating Expense
PC / PPC	Peoples' Committee/Provincial Peoples' Committee
PPP	Public-Private-Partnership
PSP	Private Sector Participation
QCVN	Vietnam (National) Technical Regulation
RBA	River Basin Approach
SBR	Sequencing Batch Reactor Technology
SSS	Separate sewerage system
TCVN	Vietnam National Standards
TF	Trickling Filter Technology
TN	Total Nitrogen
TSS	Total Suspended Solids
U3SAP	Sanitation Sector Strategy and Action Plan
VND	Vietnamese Dong
UNICEF	United Nations Children's Funds
USD	United States Dollar
WB	The World Bank
WHO	World Health Organization
WSP	Water and Sanitation Program
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

Introduction

1. Vietnam is facing the challenge of trying to keep pace with increasing environmental pollution associated with rapid urbanization, especially in the larger cities. Over the past 20 years, the Government of Vietnam has made considerable effort to develop urban sanitation policies, legislations and regulations and to invest in urban sanitation including wastewater treatment systems.
2. This study is one of three country studies conducted in the emerging countries of Vietnam, Philippines and Indonesia as part of the East Asian Urban Sanitation Review. It reviews the effectiveness of the wastewater sector in Vietnam and makes recommendations to the Government on actions to scale up the sector to improve its performance. Lessons that emerge from this study can be considered for the on-going and/or the next generation of wastewater systems.

1. Wastewater Sector Performance in Vietnam

Main Findings on Sector Performance

3. **Since 1998, the Government of Vietnam has initiated policies and provided investment to improve urban sanitation resulting in significant progress in development of the wastewater sector.** Achievements are as follows:

- Provision of wastewater services to the urban poor has been impressive with open defecation now eliminated.
- Access to toilets is now **94 percent**[1], with 90 percent of households using septic tanks as a means of on-site treatment.[2]
- **60 percent** of households dispose of wastewater to a public sewerage system, primarily comprising combined systems.[3]
- By 2012 some 17 urban wastewater systems had been constructed in Hanoi, Ho Chi Minh City and Da Nang and another five systems in provincial towns and cities with a total capacity of **530,000 cubic meters per day (m^3/day).**
- Currently some 32 new wastewater systems, primarily comprising combined systems, are in the design/construction phase.
- During the past decade annual sanitation sector investment has been USD 150 million or USD 2.1 billion for drainage and wastewater during the period 1995-2009. This represents **0.45 percent of GDP** annually.[4]

4. **Despite these impressive initiatives, urban sanitation continues to face critical issues that need to be urgently addressed:**

- Although 60 percent of households dispose of wastewater to a public system, much of this is directed informally to the drainage system and only 10 percent is treated.
- While 90 percent of households dispose wastewater to septic tanks, only 4 percent of septage is treated. Fecal sludge management is generally poor in most cities.

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[1] JMP, WHO – United Nations Children's Fund (UNICEF), 2008.

[2] Nguyen V. A., 2012.

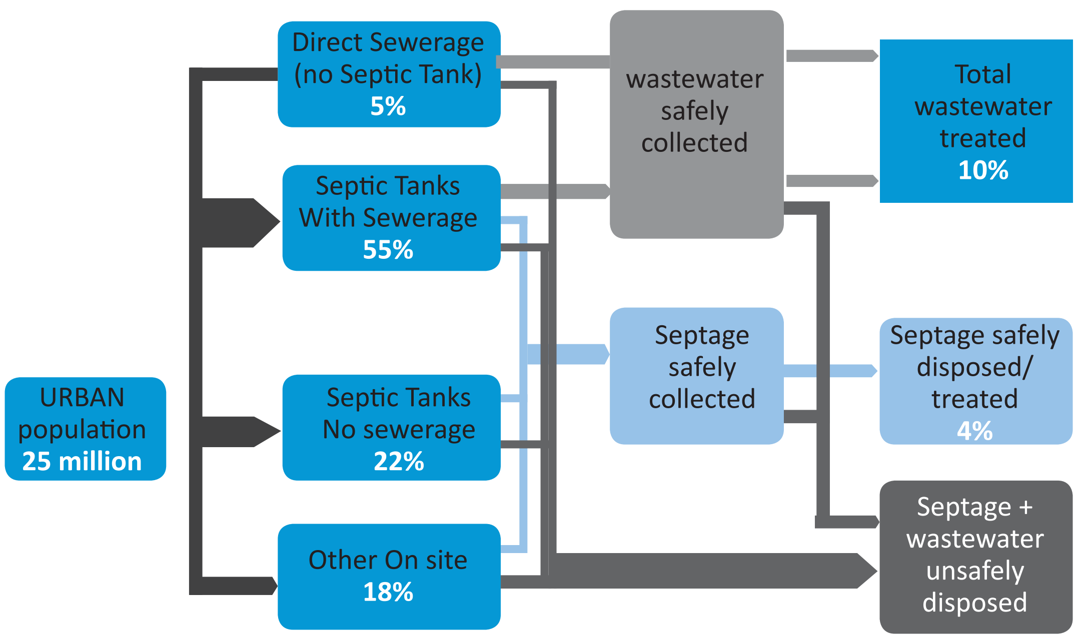
[3] Nguyen V. A., 2012.

[4] Grontmij – Water and Sanitation Program (WSP), 2012.

- The focus of wastewater expenditure to date has been in constructing treatment facilities, but this has not always been accompanied by appropriate collection systems.
- Despite wastewater tariffs in the order of 10 percent of water tariffs being charged, cost recovery of the capital and operations and maintenance (O&M) costs of the wastewater systems is generally low.
- Institutional arrangements do not encourage efficient system operation with the wastewater enterprises having limited autonomy to manage operations and undertake system development.
- Financing needs are still very high, estimated to be USD 8.3 billion to provide sewerage to the estimated 2025 urban population of 36 million. This needs to be addressed in the context of the estimated economic losses resulting from poor sanitation of USD 780 million per year or 1.3 percent of GDP (WSP, 2007).

5. The current sector performance is illustrated in Figure 1 below.

Figure 1. Status of urban wastewater management in Vietnam



Source: World Bank, 2013

Sector Performance Analysis

6. **Integrated water resource management and river basin management principles.** Even though ''Integrated Water Resource Management'' and ''River Basin Management'' approaches are mentioned in the legal documents such as the Law on Water Resources (1998, revised in 2012), the Law on Environment (2005), and River Basin Commissions have been established for the three principal river basins in Vietnam, these approaches are not yet implemented in practice.

7. **Institutional arrangements and ownership.** Most urban wastewater enterprises do not own the wastewater system assets, but operate the system under the mechanism of a ''work order from the city authority'' and are paid directly from the city budget. The current practice of providing the enterprises with a fixed annual budget for operations does not allow the enterprises to invest in research and development or in the optimization of the wastewater system. Unplanned expenses

must be approved by different administrative bodies of the city which takes considerable time and can result in loss of sewerage services.

8. **Effluent standards.** Regulations controlling effluent standards have undergone significant change since the first standard was issued in 1995 (TCVN [Vietnam National Standards] 5945:1995) with six revisions between years 2000 and 2011. This has created continuing uncertainty among local authorities responsible for implementing wastewater projects. It is important that the treatment technology used to meet the effluent standards should be carefully reviewed so that low cost options that do not put additional burden to increase operating expenditure (OPEX) and wastewater tariffs are considered.

9. **Wastewater treatment plant technology selection.** Despite the low concentration of influent BOD and other constituents measured in the flow to the 13 WWTPs currently being served by combined sewer systems, eight[5] of these are now operating based on conventional activated sludge treatment solutions. Twenty-five (of the WWTPs currently under design or construction will be based on similar technology. The lack of household connections, partial treatment/decomposition of organic matter in septic tanks and the drainage canals, infiltration of groundwater and collection of rainwater runoff all contribute to the dilution of the collected sewage in these combined systems. Given the low organic loading at these treatment facilities, lower cost appropriate technologies could have been adopted which would allow for upgrading as the influent strength increases over time. However, a lack of understanding by decision makers of appropriate technical solutions and the limited land available for the WWTPs has resulted in a continuation of more expensive, advanced technology facilities. Facilities which emphasize low power consumption, resource recovery from sludge or reuse of treated wastewater are not currently given high priority by planners in Vietnam.

10. **House connections** to public sewerage systems are an essential component to ensure most of the organic loading is conveyed to the treatment facility, no matter whether the wastewater is collected by means of a combined or separate sewerage system. However, in Vietnam, house connections are not mandated for combined sewerage systems (CSS) and are generally only employed where soil percolation is low such that discharge to the drain is the only means of disposal from the vicinity of the household. Most connections to combined systems are from the septic tank, where some pre-treatment is effected, which is one of the contributing factors for the low influent organic loading received at downstream WWTPs from combined systems.

11. **In separate sewerage systems (SSS), all households within the sewerage service area must have connections as these constitute the only source of flow to the system.** Generally, direct household connections to the SSS-based systems are mandated by local authorities and the septic tanks are decommissioned. This has resulted in higher concentrations of influent BOD experienced for SSS-based systems in Da Lat and in Buon Ma Thuot cities.[6]

12. **Septage management.** Currently there is no effective septage management being practiced anywhere in Vietnam with scheduled emptying of septage from septic tanks being practiced only in one city (Hai Phong). Some cities provide treatment of septage at wastewater treatment plants or at solid waste dumping sites. Poor design and operation of most household septic tanks plus uncontrolled fecal sludge emptying, transportation and dumping, mostly by private service providers, are common in Vietnamese cities contributing to a growing environmental problem.

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[5] The average influent BOD for these 13 WWTPs is 67.5 mg/L (see Table 1.1 of the Main Report)

[6] See Table 1.1 in the Main Report.

13. **Sources of funding.** The past 10 years have seen a growing investment in urban sanitation and especially wastewater treatment in both large and medium cities primarily supported by Official Development Assistance (ODA) funding. However, the efficiency of this investment that has focused largely on provision of treatment facilities with limited development of collection systems is yet to be established. An appropriate strategic or programmatic approach that would lead to a better targeting of investment to address the particular environmental and public health deficiencies, followed by proper investment planning is needed.

14. **Financial commitment and cost recovery.** Despite being fundamental for financial sustainability, little has actually been done to achieve cost recovery. The majority of local authorities seem willing to continue to subsidize operations. The cost recovery principle is clearly stated in Decree 88, but this should be committed and put into action by the local decision makers. Cost recovery is also impacted by operation and maintenance expenses which are a function of the level of technology selected.

15. **Participation of the private sector.** Appropriate policies and incentives are not in place to encourage private sector participation in the wastewater sector from both financial and operational perspectives. In particular, inadequate tariffs and the lack of an effective regulatory system are principal barriers for private sector entry. To date, there are few examples of wastewater projects with private sector participation initiated in Vietnam.[7]

16. **Public awareness and behavior change.** The benefits of public awareness tend to be ignored by most urban wastewater companies. Sanitation investments tend to be top-down and subsidized with limited participation by the communities. This results in an inadequate understanding by the community of the benefits in terms of the environment and public health of a well-designed and operated wastewater system. The outcome is less willingness to pay to achieve cost recovery and a reluctance to connect to the wastewater system.

2. Key Messages and Recommendations

Messages for National Policy Makers to consider

17. **Establish a national strategy applying integrated water resource management principles.** Consider developing a national strategy that applies the principles of Integrated Water Resources Management and a River Basin approach to urban sanitation in order to sustain the commitment by central government to sanitation improvement and elevate urban sanitation on the political agenda. The Law of Environment 2005 and the Law of Water Resources 2012 could form the legal basis for this approach which would include the establishment of clear regulatory mechanisms for the sector, the consolidation of service providers and an emphasis on water quality management across river basins as well as improved sector performance monitoring at the central level. This approach would allow the integration of water supply, sanitation and hygiene in order to improve coordination between government agencies, the private sector and communities. A national strategy and a National Target Program for Urban Sanitation would also ensure that the results are sustained and create a common basis for identifying priorities, developing technical and institutional capacity and establishing financial mechanisms to raise and consolidate funds to meet these priorities.

18. **Develop appropriate financing policies and mechanisms for the sanitation sector for both investment and O&M.** This may include grant finance, government bonds, appropriate tariff measures, PPP

[7] Currently only the Build and Transfer projects in Da Nang and Hanoi have included an element of private sector participation.

arrangements and other innovative sources of finance such as the introduction of property taxes or earmarked increases in personal income taxes. Increasing the wastewater tariff is a key tool to achieve O&M cost recovery and system sustainability and should be pursued.

19. **Develop policies to address utility reform of the sanitation sector.** The sector would benefit from the creation of an enabling environment to encourage the establishment of corporate utilities or private sector organizations delivering an integrated service including water supply, sewerage, sanitation, and septage management. This would require encouraging increased autonomy of the utility companies, adopting performance management approaches for O&M, addressing tariff reform to achieve cost recovery, introducing regulatory policies including an independent regulator and providing capacity building programs for service providers.

20. **Develop policies to encourage Public-Private Partnerships (PPP) and Private Sector Participation (PSP).** Policies could be introduced encouraging private sector participation in the sanitation sector including actions to improve the business working environment such as access to loans and increases in wastewater fees to provide for O&M cost recovery. Integration of water and wastewater services would make the sector more viable. Private sector investors in land development could include wastewater collection and treatment capital expenditure in costs of land or housing which will subsequently be sold to the customers at market prices, thereby reducing government expenditure. There are several potential PSP modalities that could be applied. In selecting PSP options it is critical that investments from the private sector and Government result in complete wastewater systems incorporating connections as well as network and treatment facilities. It is important that infrastructure developed by the private sector is aligned with the city's Master Plan. Encouraging private sector involvement in septage management would particularly benefit the sector given the limited capacity of public service providers.

21. **Allow some flexibility in effluent discharge quality based on receiving waters.** The assimilation capacity of receiving waters as well as the influent quality should be considered in the design of treatment facilities. Current effluent standards require that wastewater be treated to high levels to achieve low concentrations of ammonia and total nitrogen which effectively precludes the use of simpler technologies, such as wastewater stabilization ponds or trickling filters. The outcome is unaffordable operation and maintenance costs. Some affordable wastewater collection and treatment options that are potentially applicable for decentralized wastewater treatment systems are simplified sewerage, baffled septic tanks with anaerobic filters and constructed wetlands and public sanitation facilities with biogas recovery. However, these treatment systems may not comply with the current effluent standards. A potential approach is to start out with lower (or no) limits for nutrient levels (for non-sensitive receiving waters) and gradually introduced more stringent standards over a period of time, during which the sanitation sector has had time to develop and financial resources have been mobilized.

Messages for the consideration of Local Government and Local Sanitation Service Providers

22. **Sanitation planning needs to adopt a strategic sanitation planning approach at the city level.** This approach would engage with the social, technical, institutional and economic factors that impact on the potential for sustainable service provision to all sectors of the urban community. Sanitation planning would benefit from being demand responsive to the needs of the users; considering incentives that improve performance of the stakeholders related to sound facility management; separating management of neighborhood facilities from downstream collection, treatment and disposal; and allowing choices between a range of technical and financial management options depending on the

particular situation. It is recommended that sanitation planning and service delivery considers the neighborhood or the community as the first level of demand expression and develops appropriate infrastructure at that level.

23. **Promote efficient institutional and regulatory arrangements at the local level.** The institutional arrangements in each City/Province are critical to effective project preparation, implementation and operation. To improve the effectiveness of service delivery, the current relationship between the wastewater service utility and the urban government - which used to be based on an annual order approved by the local government - could be replaced by, for example, a management contract for operation and maintenance of the wastewater system. A regulatory body with participation of provincial authorities and the public could be established with a mandate that includes approving unit prices and tariffs for wastewater services. Regulations issued by the local authority regarding wastewater should include the design and construction of septic tanks, mandatory de-sludging and authorized disposal of septage.

24. **Adopt centralized or decentralized wastewater systems depending on the local situation.** Centralized wastewater systems are not considered as an appropriate solution for all of Vietnam's sanitation problems. Decentralized systems could be considered as an option for areas that cannot be economically serviced by a centralized network. Over time, these decentralized systems may become part of an expanded centralized network as population density increases. The citywide sanitation strategy developed at the master planning stage should consider identifying a staged strategy for the development of both centralized and decentralized systems. Decisions on project phasing and selection of prioritized areas of investment would benefit from being based on comprehensive analysis, with least cost analysis and affordability being keys to decision making.

25. **Select appropriate wastewater treatment technologies.** The scaling up of the sanitation sector in Vietnam would benefit from greater emphasis on the selection of treatment technology. It is important that the technology selected suits the influent wastewater characteristics, the performance requirements based on effluent standards, the specific site conditions and the receiving waters. Decision makers at all levels could be encouraged to participate in the selection of those technologies and designs that not only successfully capture the financial and economic benefits of sanitation, but that do so at an affordable cost. Septic tanks will continue to play an important pre-treatment role for existing urban areas having combined sewer systems. Septic tanks and septage management should be considered as an integral component of the sewerage and drainage system.

26. **Ensure house connections are an integral part of wastewater system development.** House connections are vital to the successful implementation of any wastewater project and their full integration within the planning and funding of the program should be considered. Improvements to both the quantity and quality of house connections to piped sewerage systems, whether they are CSS- or SSS-based, would allow the most effective use of public wastewater infrastructure. It is recommended that this process should be started through the establishment of enforceable regulations which mandate that all households, commercial establishments and institutions within a constructed sewerage collection network service area be connected to the system.

27. **Prepare a roadmap to increase revenue and achieve cost recovery.** It is recommended that the management and O&M of the wastewater collection and treatment systems are funded through wastewater tariffs paid by households.Willingness to charge customers to recover costs should be considered as a part of local authority wastewater policy. Increased cost recovery would ensure better compliance with the "polluter pays" principle and improve financial sustainability. Operating

authorities in conjunction with local provincial governments should consider increasing revenue to support operation costs. This may be achieved through a gradual increase in tariff over time so as not to cause social and economic hardship to the community. Financial support for poor households' sanitation needs could be provided through tariff cross subsidies or through micro-financing programs such as micro-credits and revolving funds.

28. **Develop the capacity of local stakeholders.** Capacity building is recommended at all levels throughout the urban sanitation sector, from the central government level down to the decision-makers at the local authority level. This would include activities to build capacity among service providers and owners of sanitation services. Increased capacity, coupled with improved coordination, would create improved performance efficiency in project implementation. It is recommended that engineered facilities be designed together with ''soft interventions'' such as capacity building, institutional and financial arrangements. Local authorities are advised to ensure that all stakeholders, from the decision makers to those employed by public utilities and service providers, have a greater awareness of the broad range of knowledge and skills required in the areas of engineering, environment and management as well as institutional and social aspects for successful project development and service provision.

29. **Increase awareness of sanitation service customers.** Information, Education and Communication (IEC) programs to promote behavior change should be implemented to increase public awareness and appreciation of the benefits of environmental sanitation. Whereas it is important for the local authorities to have the necessary "tools" for charging customers for sanitation services, it is equally important that the customers themselves be aware of the benefits and be willing to pay for those services. It is recommended that an IEC campaign be included in the development of every wastewater project to increase awareness of sanitation issues in general, but more specifically to inform people of the benefits provided by the system. This would encourage customer support for connecting their household sanitary piping to the public sewerage system, increase their willingness to pay, and result in an increased level of fees collected with consequent improvement to cost recovery. Awareness campaigns could also be utilized to promote user awareness of wastewater regulations including those relating to the design and construction of septic tanks, mandatory de-sludging and authorized disposal of septage.

MAIN REPORT

1. Sector Performance Review

1.1. Background and Introduction

1. The Vietnam Country Study forms part of the East Asia and the Pacific Region Urban Sanitation Review, a regional report which focuses on three of the emerging middle-income countries of East Asia: Indonesia, Vietnam and the Philippines. This Review aims to develop a regional strategic framework to help guide national urban sanitation programs and their implementation in the East Asia region. The envisioned strategic framework is intended to serve as a resource for key decision-makers to facilitate and make more effective the implementation of strategies for improvements to urban sanitation programs. The regional framework is also intended to facilitate discussions at the national level between international financial institutions, other donors and counterparts from the other three participating countries.

2. Country studies, carried out in the three locations, have contributed to the regional report. This Vietnam Country Study has closely investigated the performance of the urban sanitation sector to note the interrelationships and cross-cutting aspects of the political economy, social, policy, technical, financial and institutional aspects of expanding sanitation coverage for all, including the poor, in a manner which is both appropriate and sustainable.

3. The field work for the Study was conducted in two missions during the period of 29 March 2012 to 31 August 2012. Internal and external reviews were conducted by the nominated peer review group, international financial institutions and national counterparts during the period November – December 2012. A consultative review workshop was held in Hanoi on December 13, 2012. Comments received from the peer reviewers and the workshop participants have been incorporated into this final report.

1.2. History of Urban Sanitation Development in Vietnam

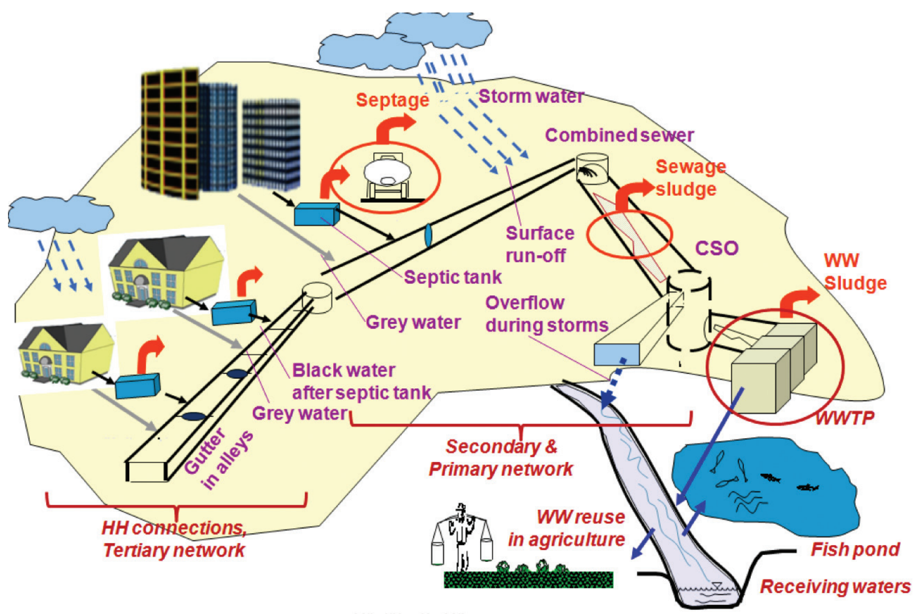
4. **Urban sanitation projects in Vietnam are best characterized by two distinct groups:** firstly, those sanitation projects being implemented in the large Vietnamese cities of Hanoi, Ho Chi Minh City (Saigon) and Da Nang; and secondly, those implemented in provincial cities and towns. Within each group there are many specific conditions which can impact on the decisions regarding the application of sanitation policy.

5. **Most cities in Vietnam have a drainage collection system, designed initially to collect rainwater runoff and reduce flooding.** As population densities increased in the urban areas, it became necessary to dispose of sewage generated by households. This need was largely met by the existing drainage systems which then began to function as combined sewers, collecting both rainwater runoff and sewage in the same drain/pipeline (Some separate sewerage systems were later built in selected locations as a response to minimizing the collected sewage flow by excluding the entry of rainwater runoff and drainage, but these continue to be in the minority.

6. **Prior to year 2000, sewage treatment in Vietnam comprised primarily of on-site treatment** such as septic tanks which were introduced by the French in their colonization of Vietnam in the 19th Century. From that period onward, it became customary and is now a government regulation that all households be constructed with some form of on-site wastewater treatment. In large urban areas, it is estimated that over 90 percent of households utilize on-site treatment, generally in the form of septic tanks (WHO – UNICEF 2008; WB – Hydroconceil & PEM 2008; Nguyen V. A. et al 2011).

7. The impact of the generated wastewater on local receiving waters created a demand for treatment and safe disposal of the collected wastewater as urban population densities increased. The first planning for wastewater treatment in Vietnam commenced around year 2000 and by year 2012 there were a total of 17 centralized urban wastewater treatment systems in the country, still relatively few in number for a country of over 87 million inhabitants. Twelve of these wastewater systems are located in the three cities of Hanoi, Ho Chi Minh City and Da Nang, with five other WWTPs scattered throughout the provincial towns and cities. In addition, more than 30 new urban wastewater treatment systems are now in the design or construction phase. The implementation process to date has been slow for a number of reasons including an apparent lack of willingness on the part of relevant authorities to make timely decisions, correspondingly slow progress associated with the design and construction phases of the work, and others which are discussed in detail in Case Study 5, Appendix C.

Figure 1.1 Typical Combined Drainage and Sewerage System in Vietnamese Cities



Source: Adapted from Nguyen V. A., 2004

With many projects now in the "pipeline", either under design or in active construction phases, Vietnam will experience rapid growth and expanded coverage of wastewater collection and treatment infrastructure. Appendix B provides a summary of sanitation projects now under design or construction.

1.2.1. Sanitation Development in Larger Cities

8. The three large cities of Hanoi, Ho Chi Minh City and Da Nang are considered separately from other cities due to their unique characteristics. For these large cities, the development of wastewater infrastructure has been influenced by the need to resolve critical urban sanitation problems associated with high population densities and inadequate drainage facilities for dealing with the increasing volumes of wastewater generated.

9. **The first large urban area in Vietnam to receive wastewater infrastructure was the City of Hanoi,** for which the JICA-funded drainage and sewerage collection systems with two wastewater treatment plants (WWTPs) of Kim Lien and Truc Bach were commissioned in year 2005 (Figure 1.2). With treatment capacities

of only 3,700m^3/day and 2,300m^3/day respectively, these two wastewater systems were intended as pilot (demonstration) facilities to provide local authorities with a better understanding of how urban sanitation could be applied in large city areas. The combined sewer catchment areas supported by the WWTPs were designed to mitigate the effects of pollutants which had previously entered the urban canals and lakes as untreated combined sewage. Activated sludge treatment technology (anaerobic-anoxic-oxic, or A2O) was utilized for these WWTPs. Each project only treats a portion of the catchment area.

10. A subsequent JICA-funded project in north Hanoi, Bac Thang Long WWTP, was constructed with the intention to serve a residential catchment area with a design population of 150,000 residents. Whereas the WWTP was placed into operation in 2009, the combined sewers were never constructed as this component was not included within the JICA-funding but was intended to be constructed from local funds. Subsequently a flow of 7,000 m^3/day of primary treated wastewater was diverted from a nearby industrial park WWTP to the Bac Thang Long WWTP, but this only constitutes 17 percent of the total design capacity of 42,000 m^3/day. This example demonstrates the need for a holistic approach to wastewater collection and treatment to optimize investments.

11. **The recent addition to the City of Hanoi sanitation infrastructure was the construction of the Yen So WWTP,** a 200,000m^3/day activated sludge treatment plant featuring sequencing batch reactors (SBRs). The wastewater catchment included all drainage tributaries to Kim Nguu River (125,000m^3/day) and Set River (75,000m^3/day), as these water courses are the principal sources for influent wastewater to the Yen So WWTP. A planned sewerage system was not constructed and the Kim Nguu River conveys the total combined sewage to the intake of the Yen So WWTP. This has impacted on the operation of the facility as the lengthy retention time in the river results in the reduction of Biological Oxygen Demand (BOD) concentration in the wastewater. This decrease in BOD has created an imbalance in the Carbon to Nitrogen (C:N) ratio of the influent wastewater which has led to operational difficulties at the WWTP.

12. **In Ho Chi Minh City, three projects have characterized the development of urban sanitation.** Firstly, a Belgian-funded project in Binh Hung Hoa district provided wastewater treatment for combined sewage collected in a local drainage canal. An aerated lagoon and stabilization pond system was constructed as the available 37 hectare land area permitted a unique, low-tech solution for such a densely populated urban area. Operational since year 2006, the Binh Hung Hoa WWTP has a design capacity of 46,000m^3/day, although only 30,000m^3/day is utilized.

13. **A second sanitation project in Ho Chi Minh City (HCMC) was the JICA-funded HCMC Phase 1 project,** which developed a combined sewerage collection system from the densely populated catchments of District 1 and District 5 in HCMC and conveyed the sewage to the Binh Hung WWTP. The project was commissioned in 2009 but the implementation period was substantially longer than expected due to complications arising from the construction of large interceptor drains in busy urban streets. The initial plant capacity, served by conventional activated sludge (CAS) wastewater technology, allowed for treatment of 141,000m^3/day, and is planned for expansion in the Phase 2 project to 512,000m^3/day in conjunction with expansion of the sewerage collection system.

14. The third urban sanitation project in HCMC is the on-going World Bank funded Nhieu Loc – Thi Nghe (NL - TN) combined sewerage collection system. This system does not currently include a WWTP, but has resulted in significant improvements to the local environmental conditions of the area. This area was once the site of densely-populated slums constructed over polluted drainage canal which long operated as the final depository for all sewage being generated within the drainage catchment. The finalization of this project in year 2011 demonstrated that significant environmental benefit could be gained by providing a sewerage

interception system which allowed for the rehabilitation of the receiving water body. Prior to the project the NL-TN area was heavily polluted contributing to serious social problems. Combined sewage, which had previously been discharged directly to this canal contributing to its degradation, is now being intercepted at combined sewage overflows (CSOs) for diversion to new interceptor pipelines. The second phase of this project will include construction of a new WWTP to be constructed in District 2 with design capacity of 480,000m^3/day for replacing the current disposal of wastewater directly into the Saigon River. A separate sewerage collection system has been proposed for District 2.

15. **For Da Nang, the sanitation infrastructure is characterized by a combined sewer system network** which supplies influent wastewater to four WWTPs each featuring covered anaerobic pond technology. These WWTPs were originally designed and constructed as open-top anaerobic ponds. However, as a result of limited buffer zone distance and odor generation concerns, all four WWTPs were subsequently covered as part of a World Bank-funded project which was completed in 2008. With a combined design capacity of 64,400m^3/day, the four WWTPs in the Da Nang wastewater system service a population of 378,000 residents or approximately 40 percent of the current City population. However, the collected combined sewage has a characteristically low organic load concentration (in terms of BOD), for which treatment is actually not required during the rainy season, causing the operators to discontinue the use of the Combined Sewer Overflow (CSO) pumping stations and release the diluted wastewater to the receiving water bodies including the beach areas on the Son Tra peninsula.

1.2.2. Sanitation Development in Provincial Cities and Towns

16. **A second group of sanitation systems is located in the provincial areas,** in which more technically diverse sanitation approaches have been implemented with regard to both the manner in which the wastewater is collected (separately or combined) and the method of treatment, ranging from simple stabilization ponds to complicated activated sludge treatment systems.

Figure 1.2 Construction of drainage canal in Hanoi City

Photo by Nguyen V. A., 2005

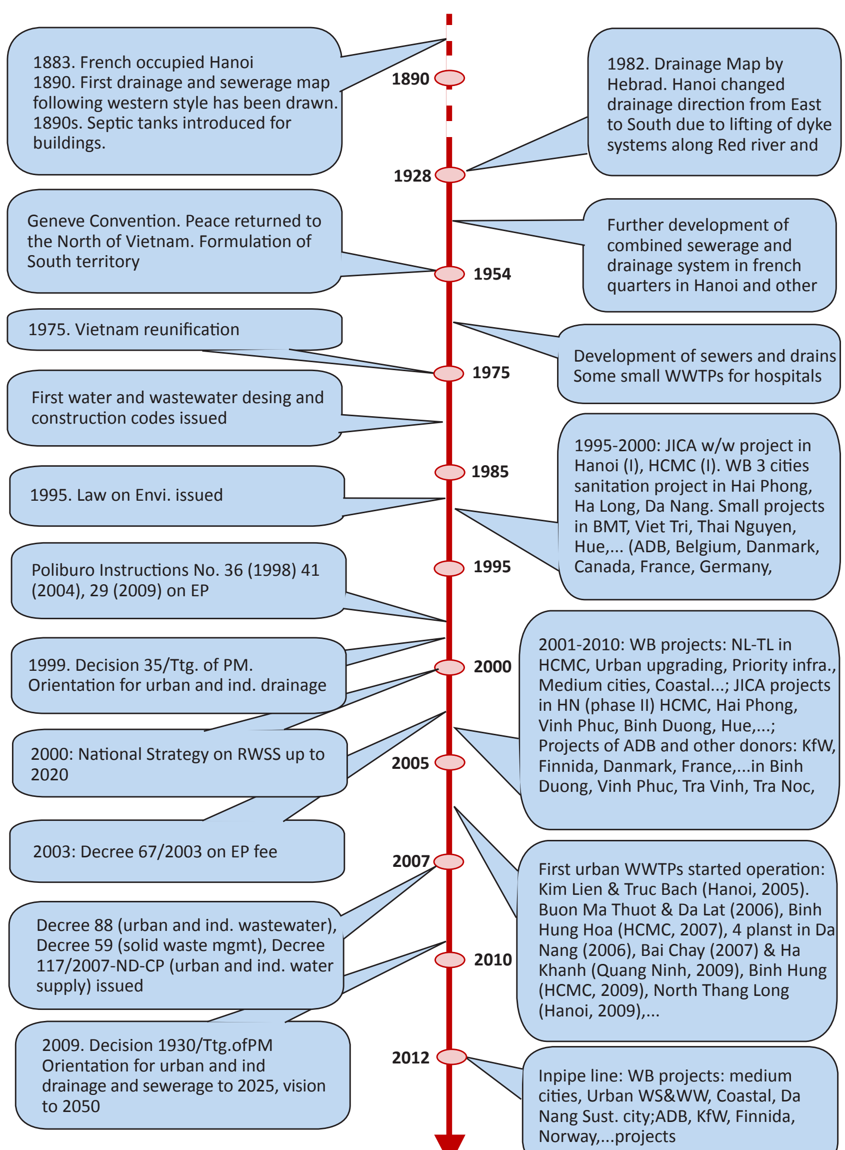
17. For the provincial wastewater systems, combined systems with household septic tanks connected directly, but informally, to the drainage system have been the norm as is the case for the City of Bac Giang and for the two sewerage catchments in Quang Ninh. However, for the two central highlands cities of Da Lat and Buon Ma Thuot, as well as in the town of Phu My Hung, near Ho Chi Minh City, sewage is collected by a separate sewerage system (SSS), which specifically excludes rainwater. This method of sewage collection has resulted in much more concentrated influent sewage flows being received at the WWTP as compared with the wastewater collected by combined sewerage systems which is characteristically much more dilute in terms of organic loading.

18. The technologies applied at the five provincial WWTPs demonstrate a broad variation in treatment process complexity ranging from very simple to complex. The first sanitation systems to commence operation in 2006 were in Da Lat and Buon Ma Thuot cities, with design capacities of 7,000m^3/day and

8,125m^3/day respectively. These Danish International Development Agency (DANIDA)-funded projects were similar in their application of cost effective solutions to treat the collected separate sewage, applying respectively the treatment solutions of trickling filters and stabilization ponds. Later more technically complex WWTPs commenced operation in Bai Chay (2007, sequencing batch reactor - SBR), Ha Khanh (2009, SBR), Chau Doc (2011, Aerated lagoon) and Bac Giang (2012, Oxidation ditch).

19. **A feature of the historical development in most urban areas in Vietnam is one of unplanned expansion** which creates difficulties in providing infrastructure to meet demand. While central and local governments are trying to set appropriate policies in the sector, traditional management models and institutional features remain in place creating key challenges for the development and efficient management of urban infrastructure including the sanitation sector. Figure 1.3 below describes diagrammatically the historical development of sanitation in Vietnam.

Figure 1.3 Vietnam Wastewater Sector Development Time Line



1.2.3. Decentralized and On-Site Systems

20. **The application of decentralized and on-site sanitation systems in Vietnam has been a mixed experience.** In urban areas, on-site (package) treatment systems have been incorporated as part of newly built large hotels, hospitals and office buildings to provide suitable treatment (Class B) prior to discharge to the combined public drainage/sewerage network. However, these on-site treatment systems at hospitals, for example, have witnessed a high rate of early failure. The septic tank, discharging to the drainage system, is still the most common type of on-site sanitation facility utilized at old public buildings, residential apartments, as well as small commercial operations.

21. The number of small-scale decentralized wastewater collection and treatment systems serving small communities has increased significantly over recent years. Examples of decentralized wastewater treatment systems using low-cost technologies include two community-based treatment systems in Lai Xa village, Minh Khai commune, Hoai Duc district, Hanoi, which utilize a baffled septic tank and an anaerobic filter followed by horizontal flow constructed wetland. A cluster (30 households) system in Kieu Ky village, Gia Lam district, Hanoi and treatment systems in the mountainous Cho Moi and Cho Ra towns, Bac Kan province, utilize a similar treatment process. The stakeholders for decentralized systems are different from those associated with larger scale centralized systems and are typically NGOs, local community residents and local government. Sustainable operation and maintenance can be a major concern for the decentralized wastewater management systems resulting from the need for local maintenance and management skills.

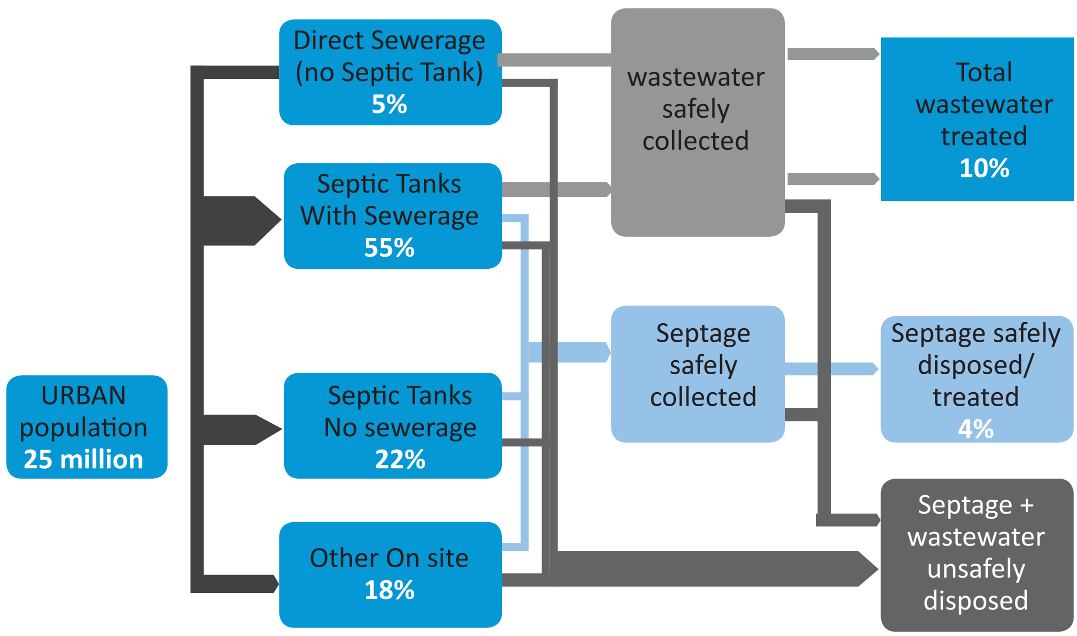
22. **Fecal waste generated by septic tank operations is, however, a major concern.** While the septic tank is the most common sanitation type in urban areas in Vietnam, sanitation systems to effectively manage fecal sludge still do not exist. Effective sludge management is going to be key activity to improve the sanitation sector in Vietnam.

1.2.4. Developments in the Sanitation Legal Framework

23. There has been significant development in establishing the legal framework for environmental protection, urban and rural infrastructure development and in sanitation/wastewater management. The first Environment Protection Law was issued in 1995 and revised in 2005. An Environmental Protection Fee imposed on urban and industrial wastewater discharges was introduced in 2003. Important Decrees on Urban and Industrial Water Supply, Wastewater Management, and Solid Waste Management were issued in 2007. The third National Target Program on Rural Water Supply and Sanitation (NTP3) implemented in the period 2011 – 2015 gives an increased focus on sanitation improvement activities. Effluent standards for different types of wastewater are being established. However, further effort is still required in order to make Vietnamese wastewater related legislation more practical and efficient.

1.3. Description of Sector Performance

Figure 1.4 Status of Urban Wastewater Management in Vietnam



Source: World Bank, 2013

1.3.1. Technical Aspects

24. Key technical issues of the sector are presented below, and Figure 1.4 summarizes the flow of human waste in urban Vietnam. The level of treatment of wastewater and septage from septic tanks is low; and a central theme in improving the sanitation sector would be to increase the collection and treatment of septage and wastewater.

Urban Sanitation in Vietnam begins at Household Level with On-site Treatment

25. **On-site systems such as septic tanks continue to form the basis for wastewater treatment in Vietnam** even when households have been connected to a public sewerage network. Exceptions to this are the Buon Ma Thuot and Da Lat systems and new development areas, which by design have eliminated septic tanks from households connected to the separate sewerage system.

26. This reliance on septic tanks for initial treatment of household wastewater is problematic given the poor management of septic tanks by most households in Vietnam. Effective operation of septic tanks requires regular de-sludging, but Vietnamese households generally only clean septic tanks when the tank overflows. As a result, a high proportion of septic tanks are overloaded, non-functional or less than effective in providing even marginal pre-treatment of wastewater prior to discharge to the public sewer system. Poorly treated discharge from septic tank systems can contribute to solids carryover to the often poorly draining combined sewers, which can lead to blocked drains and odor generation.

Sewerage Collection Systems in Vietnam

27. High rates of household connection to sewerage collection systems (including direct connection of septic tanks to the drainage system) in Vietnam occur due to the basic necessity to dispose of household-generated wastewater off-site. In most large cities such as Hanoi, Ho Chi Minh City, Hai Phong and in other provincial cities, the underlying soils drain poorly and do not allow on-site disposal solutions. Households facing this situation have little choice but to seek disposal options elsewhere, which is typically to the drain located in front of the house. The connections of households to public sewerage systems are generally not designed or implemented properly. This informal connection of household-generated wastewater to public drains is common practice in Vietnam which has led to unacceptable odor conditions in many neighborhoods. By contrast, the household connection ratio is very low in small and remote towns, in peri-urban areas and in the urban areas of central region, where soil is mostly sandy allowing for percolation into the subsoil. For example, the World Bank survey in Da Nang city in 2012 has shown the connection ratio to the sewerage system was below 10 percent for central areas, where most of septic tanks discharge to soak pits *(Da Nang PMU report on WB project survey,* 2012).

How well is the Sector Performing Technically?

28. **High access to sanitation but limited environmental impact.** There is considerable scope to improve wastewater service coverage with only an estimated 10 percent of the total wastewater generated in urban areas actually receiving some form of treatment. To date, a relatively low priority has been placed on development of sanitation sector infrastructure, in particular the collection system and household connections. The principal reasons behind this weak performance include lack of access to funding for carrying out the work, lack of technical knowledge on the part of key decision-makers to make informed technology choices and limited enforcement capacity of the urban management authorities.

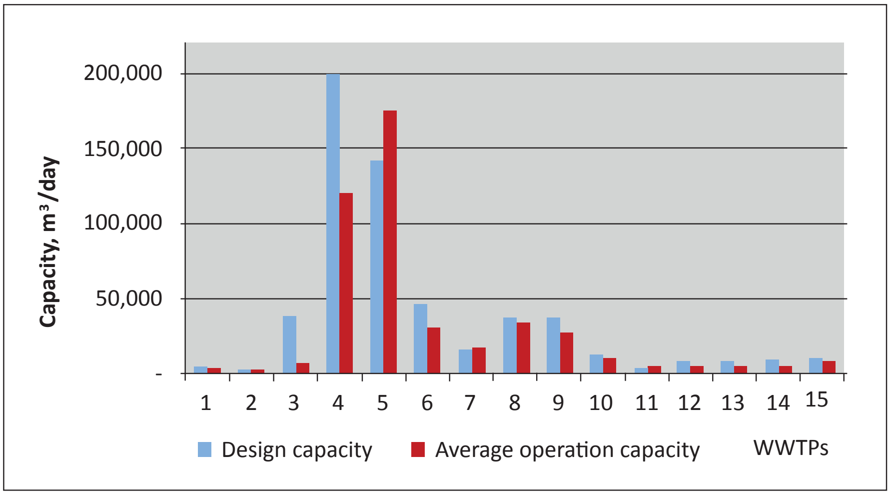
Operational Performance of Urban WWTPs in Vietnam

29. There is a clear distinction in wastewater characteristics between combined sewerage and separate sewerage systems as illustrated in Figure 1.5 and Table 1.1. Only four of the surveyed 17 centralized WWTPs are served by SSS systems, whereas the other thirteen WWTPs are all served by CSS systems. The WWTPs receiving wastewater from CSS-based systems had influent BOD concentrations ranging from 31 to 135 mg/l with an average of 67.5 mg/l[8] compared with those receiving wastewater from SSS-based systems (Buon Ma Thuot and Da Lat) which had influent annual average BOD concentrations ranging from 336 to 380 mg/l and an average of 358 mg/l. Other parameters showed similar variations, as shown in Figure 1.5.

[8] Statistical annual average values collected from 13 studied WWTPs. Seasonal fluctuation of incoming flow concentration was not reported by the WWTPs.

Actual Functional Capacity versus Design Capacity

Figure 1.5 Actual Operation Capacity of 15 of the 17 Surveyed WWTPs versus Design Capacity



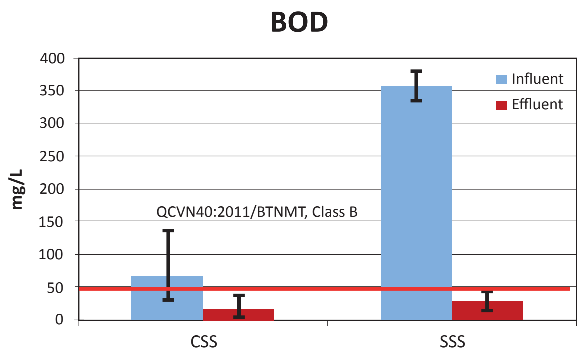
Note: 1-Kim Lien plant; 2-Truc Bach plant; 3-Bac Thang Long plant; 4-Yen So plant; 5-Binh Hung plant; 6-Binh Hung Hoa plant; 8-Son Tra plant; 9-Hoa Cuong plant; 10-Phu Loc plant; 11-Ngu Hanh Son plant; 12-Bai Chay plant; 13-Ha Khanh plant; 14-Dalat plant ; 15-Buon Ma Thuot plant

30. **The operating capacity of the municipal WWTPs ranges from 18.4 to 128 percent of their design capacity.** Figure 1.5 presents a comparison of the actual operational capacity of the 15 of the 17 surveyed WWTPs (see Table 1.1 for the names of these treatment plants) versus design capacity. Some WWTPs such as Kim Lien and Truc Bach (Hanoi), Binh Hung (HCMC), Son Tra (Da Nang), Bai Chay (Quang Ninh) are operating at higher capacity than the design values, while the others are operating below design capacity. The lowest utilization is at Bac Thang Long WWTP, Hanoi city (18.4 percent) which, due to a lack of sewerage connections, is only receiving wastewater from a nearby industrial zone and not from the proposed residential service area. This lack of utilization of the WWTP is an illustration of WWTP construction that was not coordinated with the construction of a sewerage network and a program to encourage household connections. Over estimation of the design flow of the WWTP at the project preparation stage is another factor.

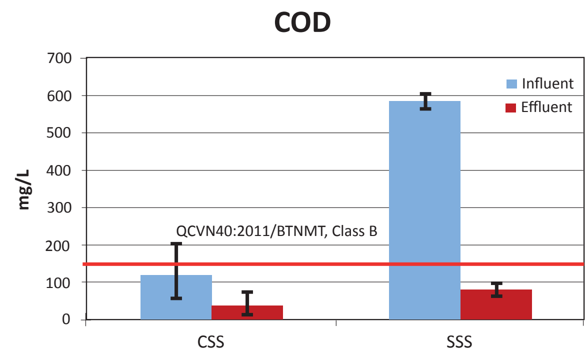
31. **Effluent standards are mostly being achieved for both SSS- and CSS-based WWTPs.** The correspondingly dilute sewage and operational capacity lower than the design value enables most CSS-based WWTPs to easily achieve effluent standards irrespective of the selected treatment technology. The treated wastewater at two of the SSS-based WWTPs (Buon Ma Thuot and Da Lat) meets standards for Class B effluent in accordance with QCVN 40:2011/BTNMT in terms of BOD, COD, total suspended solids (TSS), and total Nitrogen (TN), but not for ammonium (both plants) and phosphorus (Da Lat WWTP).

32. Significant differences in wastewater characteristics between the two sewage collection methods should be carefully considered in wastewater project planning and technology selection. The high percentage of household connections and the direct connection from the household to the sewer (eliminating the septic tank) in SSS systems makes concentration of pollutants in incoming wastewater is much higher than in CSS-based systems (see Figure 1.6). However, the assumptions on loading rates used in the design of treatment facilities and selection of technology have not, to date, distinguished between collection systems.

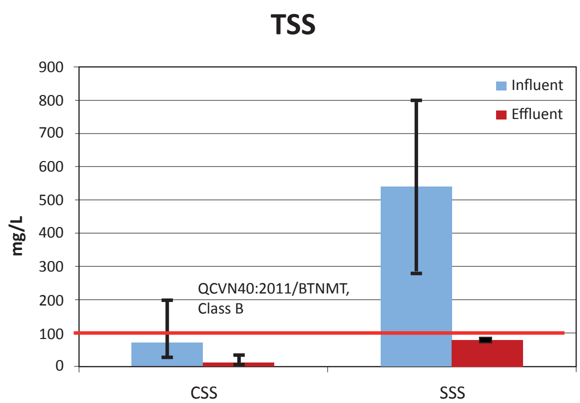
Figure 1.6 Differences in Concentration of Pollutants at CSS versus SSS Systems



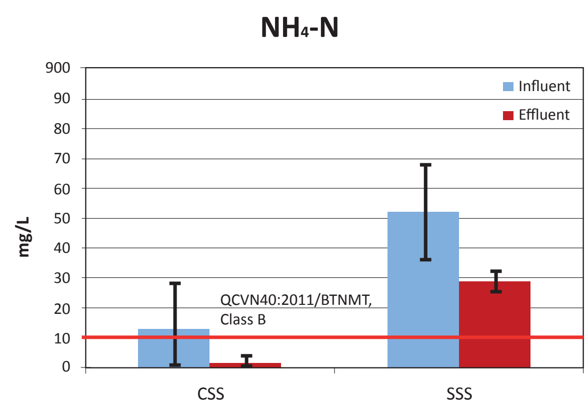
(a) BOD concentration in CSS and SSS



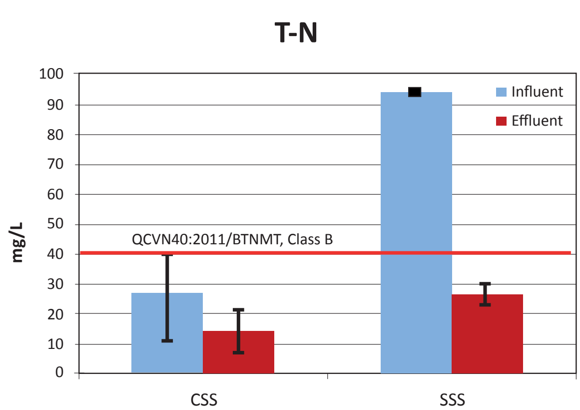
(b) COD concentration in CSS and SSS



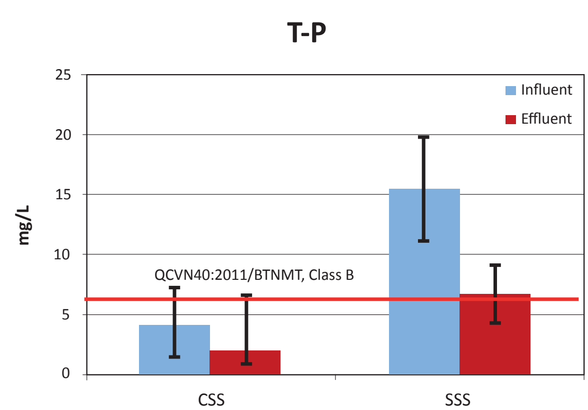
(c) TSS concentration in CSS and SSS



(d) NH_4-N concentration in CSS and SSS



(e) T-N concentration in CSS and SSS



(f) T-P concentration in CSS and SSS

Note: Bars indicate average, max and min values as annual average from all surveyed WWTPs

Table 1.1 Treatment Performance Indicators of 15 from 17 Surveyed[9] Operating Urban WWTPs in Vietnam[10]

No.	WWTPs	City	Treatment process	Sewage system	BOD (mg/L)		COD (mg/L)		TSS (mg/L)		NH_4-N (mgN/L)		T-N (mg/L)		T-P (mg/L)		Coli-form (MPN/ 100mL)	Applicable Effluent Standard
					Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Eff.	
1	Kim Lien	Hanoi	A2O (AS)	CSS	115	9	145	18	85	5	18	-	40	17	6.5	1.7	0	TCVN5945-2005, B
2	Truc Bach		A2O (AS)	CSS	135	8	155	15	85	5	-	-	34	16	6.5	1	0	TCVN5945-2005, B
3	Bac Thang Long		A2O (AS)	CSS	85	12	135	16	65	8	-	-	38	12	5.4	0.85	100	QCVN40-2011, A
4	Yen So		SBR (AS)	CSS	45	6	132	24	51	10	28	0.5	34	8	7.2	6.5	-	QCVN40-2011, B
5	Binh Hung	Ho Chi Minh City	Aer/Mat Ponds	CSS	42	3	135	30	103	7	-	-	11	7			175	QCVN14-2008, B
6	Binh Hung Hoa		CAS	CSS	78	10	203	50	49	18	17.9	3.3	-	-			-	QCVN14-2008, B
7	Son Tra	Da Nang	OD (AS)	CSS	37	25	67	49	38	19	-	-	18	14	1.7	1.4		QCVN40-2011, B
8	Hoa Cuong		A2O (AS)	CSS	63	31	115	60	59	23	-	-	23.6	18.6	1.9	1.5		QCVN40-2011, B
9	Phu Loc		Ana. pond	CSS	96	37	169	73	71	23	-	-	28.3	21.4	2.2	1.8		QCVN40-2011, B
10	Ngu Hanh Son		Ana. pond	CSS	31	22	60	44	27	16	-	-	15.6	12.9	1.4	1.1		QCVN40-2011, B
11	Bai Chay	Quang Ninh	Ana. pond	CSS	36	20	80	32	196	11	1.3	0.79					13	
12	Ha Khanh		Ana. pond	CSS	45	23	68	68	41	35	1.1	1					43	
13	Da Lat	Da Lat	SBR (AS)	SSS	380	14	604	65	792	82	68	25.6	95	30	19.7	9	-	QCVN24-2009, B
14	Buon MaThuat	BMT	SBR (AS)	SSS	336	45	564	98	286	76	36.4	32	93.7	23	11.2	4.3	15000	QCVN24-2009, B
15	Bac Giang	Bac Giang	Imhoff Tank/ TF	CSS	90	-	120	25	-	-	-	-	-	-	-	-	-	QCVN14-2008, B
QCVN 40:2011/BTNMT, A class						30		75		50		5		20		4	3000	
QCVN 40:2011/BTNMT, B class						50		150		100		10		40		6	5000	

9 Detailed data from 2 WWTPs Canh Doi and Nam Vien in Phu My Hung new urban development area, HCMC were not available during the study.

10 Latest information update: newly commenced WWTPs in Vietnamese urban areas: Phan Rang, Ninh Thuan province (design capacity 5,000 m^3/day, commenced in 2012), Vinh city, Nghe An province (design capacity 25,000 m^3/day, commenced in 2012), Bac Ninh city, Bac Ninh province (design capacity 17,500 m^3/day, commenced in 2013), Thu Dau Mot city, Binh Duong province (design capacity 17,650 m^3/day, commenced in 2013), Soc Trang city, Soc Trang province (design capacity 13,000 m^3/day, commenced in 2013).

Comparison of Treatment Technologies

33. **Treatment technologies utilized also vary widely between the seventeen WWTPs surveyed during the study.** The names of these plants are mentioned in Table 1.1. Eight of the thirteen WWTPs from the CSS-based delivery group could be characterized as activated sludge technology, in the form of conventional activated sludge, A2O process, SBR or Oxidation Ditch (OD). Each of these processes is designed to treat the incoming wastewater to a high level of quality and would have typically been designed for treating incoming BOD of a much higher concentration than is actually currently being received. For this reason, it is reasonable to expect that these eight WWTPs would comply with the applicable effluent standards. For example, the average effluent BOD from the eight WWTPs of the CSS group ranges from 3-23 mg/l, far below the effluent standard for Class “B”, which is typically 50 mg/l. Given the low loading at these plants, it would have been possible to meet effluent standards through phasing of the WWTP construction or by adopting lower technology solutions, thereby saving on capital expenditure.

34. The two WWTPs at Da Lat and Buon Ma Thuot, which receive more concentrated SSS wastewater flows, are both based on less complex treatment technologies. Da Lat WWTP utilizes a primary/secondary flow train of an Imhoff Tank followed by a trickling filter, whereas the Buon Ma Thuot WWTP utilizes a three stage stabilization pond system consisting of anaerobic, facultative and maturation flow trains. While each WWTP is capable of meeting the majority of the required effluent standards for BOD, Chemical Oxygen Demand (COD), TSS and TN, each has specific performance limitations for ammonia, as noted in Table 1.2.

35. The Da Lat WWTP is unusual in that it receives influent ammonia concentrations averaging 67mg/l, compared to an influent ammonia level in Buon Ma Thuot of 36mg/l. The high ammonia levels at Da Lat are influenced by a slaughterhouse which discharges untreated wastewater directly to the SSS as well as septic tanks pumpers which discharge as many as three truckloads per day of septage to the inlet works of the WWTP. The level of treatment provided at Da Lat through Imhoff tanks and trickling filters is insufficient overall to achieve the effluent ammonia limits given the high incoming concentrations of ammonia. Similarly, at the Buon Ma Thuot WWT which receives a high influent concentration of ammonia from the SSS, the stabilization pond systems cannot reliably achieve nitrification (ammonia removal). The situation at Da Lat should be addressed through pre-treatment by the industry prior to discharge to the sewer. The Buon Ma Thuot WWTPs may need augmentation to achieve current effluent standards for ammonia, although as the effluent is re-used for coffee irrigation it may be possible to be more flexible with the standard.

36. The feasibility and design stages for sanitation projects have often failed to adequately consider differing situations that could influence the technology decision-making process. The absence of comprehensive sanitation planning in accordance with urban development plans has been a contributing factor to this situation. A prime example in Vietnam is the choice between the use of CSS- versus SSS-based sewerage delivery systems. Ultimately, the choice between these two design concepts should guide all downstream elements of the project development. Opportunities to consider more appropriate treatment technologies were not considered due to land not being allocated during the planning phase or in favor of solutions that were “popular” or simply followed what had done in other provinces. Furthermore, wastewater collection and treatment systems with incomplete components do not bring significant environmental improvement. This is particularly true in the cases of Bac Giang, Bai Chay, Ha Khanh and some of the new WWTPs, all utilizing activated sludge plants which treat very low strength influent wastewater collected by incomplete CSS systems. In the case of Bac Thang Long, almost no urban development and no collection network has been built although the WWTP has been operating for several years. For Da Nang city, four

WWTPs were constructed using open-top anaerobic pond technology which was inappropriately chosen given the location of the WWTP s in populated areas having a very limited buffer zone. The ponds were later covered as a result of public concern over odor, but this action has now placed new constraints on the operability of the facilities, as the covers preclude normal access for maintenance and de-sludging.

37. **The significance of providing house connections for a combined sewer network is commonly neglected during project development.** Connecting households, even in a CSS network, will increase the organic loading of the collected sewage. The reverse of this is particularly evident in Da Nang, where favorable underlying soil conditions permit on-site disposal of household septic tank effluent. The outcome of this in Da Nang is the measured low quality organic level in the sewage received at the WWTPs as only limited organic loading enters the collection system.

Sewage and Wastewater Sludge Treatment

38. **Currently the only method adopted for treating and disposing of sludge generated at the WWTPs is dumping at landfills.** Combined sewerage and drainage systems generate sludge with very complicated composition and high inorganic content which is not suitable for resource recovery. A number of cities are facing difficulties in allocating space for WWTP sludge disposal. One WWTP in Da Lat is trialing composting from sludge dewatered in sludge drying beds (Figure 1.7). There appears to be a good demand from the vegetable and flower farms in city for this compost. The Binh Hung WWTP (HCMC) is also making compost from mechanically dewatered sludge. However, in this case the lack of a market for the compost and the strong odor from sludge treatment facilities represent significant concerns for the WWTP.

39. **Resource recovery from sludge is not a focus of wastewater projects.** This is a topic for consideration in the coming years while management models, market demand, standards and control are established together with appropriate treatment and utilization technologies. Only the Yen So WWTP, with capacity of 200,000m^3/day, has been designed with anaerobic digesters for sludge stabilization. Biogas collected is intended to be sent to flare for burning out. However, sludge and biogas have not been produced to date since the WWTP is not working at full capacity and the low strength influent from the combined flow contains insufficient carbon.

Fecal Sludge Management (FSM)

40. **No city in Vietnam has yet developed a clear strategy for FSM or implemented an acceptable treatment technology.** The most common FSM practice by both public and private emptiers is dumping at landfills. Many private emptiers are still illegally dumping septage to drains, sewers, ponds or open land. In some cities where centralized WWTPs have been built, such as Buon Ma Thuot and Da Lat, septage is brought to the plant headworks and co-treated with wastewater. This option should not affect the plant operation in terms of hydraulic and organic loadings. However, high (500-1000 mg/l) ammonia concentration present in the septage waste and high loads of pathogens and parasites may create imbalance of the C:N ratio in biological treatment trains, as well as producing unsafe microbial effluent quality. Other centralized WWTPs have selected co-treatment of septage with sewage sludge on sludge drying beds after lime conditioning (Ha Long, Bai Chay WWTPs). However, although these lime conditioning plants were commissioned, they are currently not operated, as observed by the Review team during their visit to these facilities. Fecal sludge management therefore does not function properly, resulting in limited septage being effectively treated.

41.**Some septage collectors are supplying septage to farmers for direct or indirect use in agriculture or aquaculture.** Some private enterprises are co-composting septage with agricultural wastes and organic wastes for making compost fertilizer. However, no clear strategy on quality control, including safe reuse of a septage-generated compost product, has been established although the Ministry of Agriculture and Rural Development (MARD) Decision 04/2007-QD bans utilization of fertilizer made from human and animal waste for vegetables.

Figure 1.7 Sludge Drying Bed at Da Lat WWTP

Photo by Nguyen V. A., 2012

1.3.2. Policy Aspects

42. A comprehensive legal framework in environmental sanitation, including urban wastewater management, currently exists in Vietnam. The framework consists of different laws, national strategies, decrees, circulars, decisions, programs and plans. However, a lack of proper synchronization as well as overlaps and gaps are found within this framework. Overly ambitious and sometimes conflicting targets for environmental protection and wastewater collection and treatment are contained in legal regulation documents prepared by various Ministries.

43. **Regulations on urban sanitation are lacking.** Despite the common prevailing use of septic tanks for household sanitation in most urban areas, no city in Vietnam regulates their design and construction. Moreover, no regulations on septic tank operation and maintenance and on fecal sludge management have been issued. Many provinces operating wastewater systems do not have regulations mandating household connections. Although not regulated, some cities implementing sanitation ODA projects have taken these issues into account in the design and management of the project.

44. **There appear to be few incentives provided to encourage private sector investment in the wastewater business,** although a policy of encouraging private sector participation in urban infrastructure is supported by the Vietnamese Government. Ministry of Finance (MOF) Circular 230/2009/TT-BTC creates favorable tax conditions for enterprises dealing with environmental protection activities, offers concrete instructions for the creation of favorable business development conditions and supports provision for private sector participation in sanitation, as stated in Decrees 04/2009/ND-CP and Decree 59/2007/ND-CP. Lack of cost recovery, cumbersome bureaucratic administrative procedures, and lack of effective regulation on service levels and tariffs are the main causes of limited private sector participation in urban sanitation.

45. **The privatization process is slowly taking place in water supply and urban wastewater companies.** The first example of a Build-Operate (for 10 years) contractual arrangement is planned for the new Da Nang wastewater project. Yen So in Hanoi is the first WWTP implemented under a Build-Transfer (BT) contract where a Malaysian firm, Gamuda, has invested USD 300 million for construction of the Yen So WWTP which later will be handed over to the Hanoi Sewerage and Drainage Company (HSDC). As a return for their investment at Yen So WWTP, Gamuda has received 150 ha land from Hanoi City where Gamuda has planned a large urban development project with an investment cost of USD 1 billion.

Wastewater Management Planning

46. Many urban wastewater projects have been approved and are being implemented in isolation without being part of a comprehensive wastewater plan. Decree 88 and its revised draft version require cities to prepare wastewater plans. However, sanitation planning is often not integrated into an urban development master plan. Regulations and specific technical guidelines for the planning, consultation and appraisal of urban sanitation development projects are still lacking – leading to the construction of WWTPs without a holistic city-wide approach to address environmental and urban development concerns.

47. Wastewater management companies are generally not involved in the design and construction phases and have no ownership of the assets. The investor (central government or local authorities) manages the design and construction before handing over to the wastewater management company for O&M. The company can then face difficulties in the operation and maintenance of sewers and wastewater treatment facilities, especially if the construction has been sub-standard. Wastewater management companies have no ownership of the wastewater system assets, which belong to the city authority (Decree 88/ND-CP) and have no right to refuse handover of a facility if it does not meet the required standard.

48. **Some decentralized systems are discharging treated effluent to the public sewer network even while meeting effluent standards.** This was observed during the site visits for a number of decentralized or onsite wastewater treatment plants, such as those for hotels, hospitals and new housing complexes located in urban catchments. This is an outcome of inadequate sanitation planning, leading to overlapping development of centralized and decentralized sewerage systems.

Wastewater Fee (Decree 88) and Environmental Protection Fee (Decree 67)[11]

49. There is a lack of clarity and overlapping of responsibilities between the Department of Natural Resources and Environment (DONRE) and the water supply companies in terms of establishing and collecting wastewater fees. In most cases water supply companies are already collecting wastewater fees. In such circumstances, it would appear that the Environmental Protection (EP) Fee implemented by DONRE overlaps with this wastewater fee already being implemented by the water supply companies. The application of the wastewater fee and EP fee is being revised through amendments in Decrees 88 and 67, respectively.

50. Decree 88 issued in 2007 is an important development in the urban and industrial wastewater sector addressing a number of key constraints that reduce effectiveness of the sector. The Decree is now being revised aiming at providing more comprehensive regulation (Figure 1.8). Some of the areas to be addressed include the development of standards for the quality of wastewater discharged to the urban sewerage and drainage system; legislation by the local authority mandating regulations on urban wastewater management; establishment of policies for mobilizing resources for urban sanitation investment;

[11] During preparation of this Report, the Decree 25/2013/ND-CP was issued on March 2013 replacing Decree 67. Further, in May 2013 the Circular 63/2013-TTLT was issued guiding implementation of Decree 25. Decree 25 has distinguished the environmental protection (EP) fee from the wastewater fee. The EP is to be collected from industrial users and from households discharging wastewater to the environment. For domestic wastewater, the wastewater system operator and the households who are not connected to a piped water system have to pay EP fee which should not exceed 10 percent of local water tariff. Since 10 percent of the water tariff is far below the wastewater tariff which should follow the principle of recovery of wastewater system O&M costs, this rule may not encourage the connection of households to the wastewater network. Separately, Decree 88 is being revised and will be re-named “tariff for wastewater collection and treatment services” instead of wastewater fee. This tariff is to be collected from all users of wastewater services.

clarification of the ownership of urban wastewater systems; and development of a methodology for wastewater tariff setting for urban and industrial wastewaters aiming at gradual O&M cost recovery.

Figure 1.8 One of MOC workshops on Revision of Decree 88

Photo by Xuan Thu, 2013

Effluent Standards

51. Application of the effluent standards in terms of design of treatment facilities does not appear to give consideration to the use of the receiving body of water. It would be beneficial to classify the water effluents into different groups of water use leading to different environmental standards.

The most common practice is to follow QCVN 24:2009/BTNMT, which was replaced by QCVN 40:2011/ BTNMT at the end of December 2011. Some WWTP operators (Bac Giang, Binh Hung and Binh Hung Hoa) are still applying QCVN 14:2008/BTNMT, which is not appropriate for centralized wastewater treatment plants. Some provinces have applied out-dated and superseded discharge standards, such as TCVN 6772:2000 and TCVN 7222:2002. A historical comparison of the "evolution" of effluent standards from year 1995 to the present is shown in Table 1.2.

Table 1.2 Historical Development of Industrial Wastewater Discharge Standards

Para.	Unit	TCVN 5945:1995		TCVN6772-2000				TCVN7222: 2002			TCVN 5945:2005		QCVN 14:2008		QCVN 24:2009		QCVN 40:2011	
		A	B	I	II	III	IV	Primary treatment	Secondary treatment	Tertiary treatment	A	B	A	B	A	B	A	B
pH	-	6-9	5.5-9	5-9	5-9	5-9	5-9	6-9	6-9	6-9	6-9	5,5-9	5-9	5-9	6-9	5,5-9	6-9	5,5-9
BOD	mg/L	20	50	30	30	40	50	100-200	10-30	5-10	30	50	30	50	30	50	30	50
COD	mg/L	50	100	-	-	-	-	-	-	-	50	80	-	-	50	100	75	150
TSS	mg/L	50	100	50	50	60	100	100-150	10-30	5-10	50	100	50	100	50	100	50	100
NH_4-N	mgN/L	0.1	1	-	-	-	-	-	-	-	5	10	5	10	5	10	5	10
T-N	mg/L	30	60	-	-	-	-	20-40	15-30	3-5	15	30	30	50	15	30	20	40
T-P	mgP/L	4	6	6	6	10	10	7-15	5-12	1-2	4	6	6	10	4	6	4	6
O&G	mg/L	5	10	20	20	20	20	-	-	-	10	20	10	20	10	20	-	-
Coliform	MPN/ 100ml	5000	10000	1000	1000	5000	5000	-	-	-	3000	5000	3000	5000	3000	5000	3000	5000

Notes

These standards are also applied for effluent discharge from a wastewater treatment plant

- A: water bodies using for sources of domestic water supply.

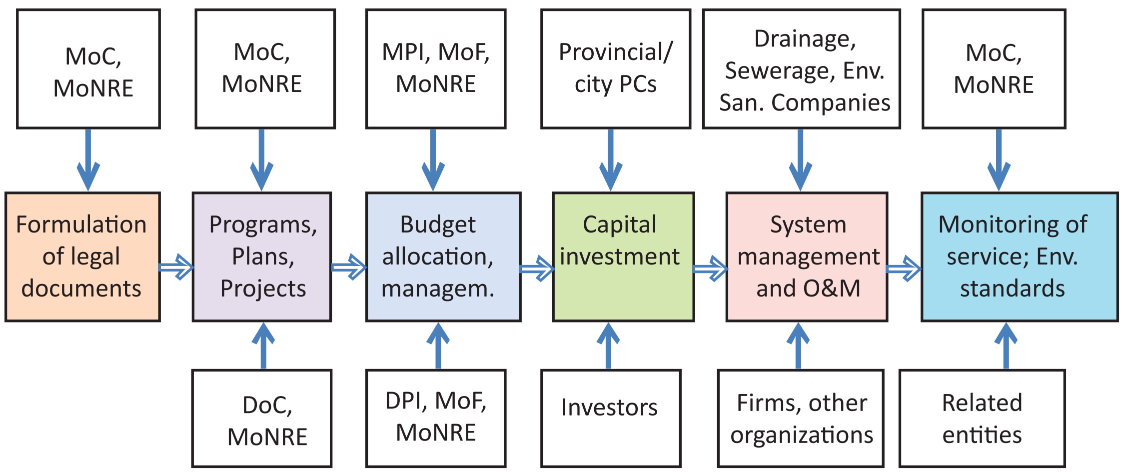
- B: water bodies using for other water usage purposes with lower quality requirements

- Level I-IV (TCVN 6772-2000): based on the size of wastewater volume generated.

1.3.3. Institutional Aspects

52. **An overview of the management responsibilities of ministries and agencies involved in drainage and sewerage management in urban areas in Vietnam is presented below** (Figure 1.9). Although ''integrated water resource management'', and ''river basin management'' approaches are mentioned in the legal documents such as the Law on Water Resources (1998, revised in 2012), the Law on Environment (2005), and River Basin Commissions have been established for the three principal river basins in Vietnam, the existing institutional structure in Vietnam does not allow these approaches to be implemented.

Figure 1.9 Matrix on State Management of Wastewater in Urban Areas in Vietnam



Adapted from Grontmij - WSP, 2012

Models for Urban Wastewater Management

52. Currently there are two models for urban wastewater management enterprises in Vietnamese cities: (a) One member (State owned) company limited; and (b) Joint Stock Company (JSC). In case of the JSC, the government holds 51 percent of the shares. The remaining stock is held by the company staff and external shareholders. Most of these enterprises are operating drainage and sewerage systems through an ''annual work order" from the city authority and are paid directly from the city budget. The normal practice of using a fixed budget as planned and approved for the annual activities does not allow the enterprises to invest in research and development or in the optimization of the wastewater system. The budget for major unexpected repairs is problematic for these enterprises and unplanned expenses generally must be approved by a different administrative body of the city. Obtaining approval can take considerable time and result in loss of sewerage services.

Figure 1.10 Cleaning of Urban Drainage Canal

Source: Water Supply and Sewerage Journal, VWSA, 2013

54. Strong and capable enterprises are found in those locations where the responsibility for wastewater and drainage services is undertaken by a single company that is also responsible for other public works such as

water supply, solid waste, green spaces, roads and pavements. In some cities, management of the urban sewerage and drainage system is divided between two or more organizations. For example, the drainage network in Bac Giang city is operated and maintained by the Bac Giang urban works management joint stock company, while the main drainage canals, sewer trunks, pumping stations and WWTP are operated by Bac Giang Flood Control Center. In the city of Da Lat, the urban drainage network is operated by an urban public works company, while the separate sewerage network and WWTP are operated by Lam Dong Water Supply and Sewerage Company. Fragmented responsibilities create challenges in coordination and limit the efficiency of the invested resources. Fragmentation is also an issue in cities where responsibility for household connections and the tertiary network fall under community and local authority management, while the urban wastewater company is responsible for the main trunk sewers and WWTP. Accountability for poor service then becomes an issue and impacts upon the consumers' willingness to pay for services.

55. **Investments will not be sustainable without addressing the regulatory framework and institutional capacity.** Greater coordination of sector agencies is also required for programs to be efficient. Some progress is being made such as through policy dialogues among key stakeholders and formation of a Donor's Sanitation Coordination Group (since 2012, led by ADB Vietnam). These activities should continue and, where possible, be expanded.

Commitment of the Local Authorities to Good Management Practices

56. **A sense of "ownership" is extremely important for the sustainable, long-term operation of WWTPs.** During the field visits to existing urban WWTPs, the Study Team observed a wide variation in operator interest, capability and motivation. This was most evident in the condition of the facilities, the best of which exhibited a high state of cleanliness, disciplined implementation of odor control measures and strong efforts to achieve effluent standards. These facilities were generally operated by personnel who could be described as having a high degree of commitment as reflected by good management and proactive operation and maintenance. The commitment of local authorities was also evident in the sense of pride in those staff assigned to carry out the work. Examples of this positive approach were the Da Lat and Buon Ma Thuot sanitation projects where the project management unit closely liaised with the designated operator of the project, establishing an early sense of involvement and interest in the project. This early involvement by the operator also allowed time for technology transfer by their participation in integrated training programs.

57. **Prior involvement in the development stage of a wastewater system encourages responsible management.** Generally, when the management of the wastewater system was assigned to a third party which had no prior involvement in the project the result was predictably poor in terms of the lack of willingness to take on the responsibility of sustainable management. Such dysfunctional practices will continue if project implementation is not undertaken in association with the organization ultimately responsible for long-term operation. It is unclear whether this dysfunctional practice will change, as funding for Provincial projects often results in the recipient, the Provincial authority (Provincial People's Committee, or PPC), assigning members of the project management units from within their own staff instead of from relevant departments such as public works or urban management companies who will ultimately be responsible for operation of these facilities.

Role of Urban Public Utilities

58. The organization authorized by the city's PC to coordinate the activities of sewerage and drainage companies is usually the Department of Construction (DOC) or DONRE. It may also be sector specific such as in the Steering Center of the Urban Flood Control Program of HCMC where short- and long-term flood control measures are integrated with the sewerage and drainage works. There are also advantages in the management model in Da Nang whereby DONRE coordinates environmental protection and urban sewerage and drainage activities. Important advantages of this management model are efficient allocation of resources for investment and O&M of urban infrastructure and environmental protection facilities and the consistent application of different regulations such as Decrees 67 (already replaced by Decree 25/2013) and 88.

59. The policy of corporatization of public utilities has neither resulted in them becoming financially autonomous, nor in improved efficiency of wastewater management companies. These companies often require large budget allocations from the PPC. Public service utilities have a dependent relationship with provincial leaders who maintain control over assets and their management. Activities carried out by the public utilities are limited to those approved by the PPC, DOC and DOF. Order or Assignment contract modes are popular in all provinces, but normally contract values cannot cover O&M costs. O&M Contracts between the drainage and sewerage system owner (the Provincial or Town People's Committee [PC]) and the service providing entity as required in article 28 of Decree 88/2007/ND-CP and Circular 09/2009/TT-BXD have not been implemented in any location. The main reason is that wastewater fees are too low and local resources are too limited to cover the contracted works (if any). The pre-conditions for an effective management model might be a clearly defined ownership of the urban wastewater infrastructure, market-based relationship among players in supply and demand of the public services, and appropriate policies enabling cost recovery of the system O&M.

60. There is no regulation regarding septic tank emptying, or sludge transportation, treatment and disposal services delivered by private enterprises. This is despite the roles and responsibilities for urban public utilities in terms of septage management being clearly stated. However, these enterprises conduct business in a purely market-based manner alongside strongly competing public utilities. For that reason, the private enterprises try to minimize running costs, which often leads to the practice of illegal septage dumping. As many of these businesses are unregistered, this effectively prevents proper coordination with the public utilities and limits their access to favorable financing and to external technical assistance.

Figure 1.11 Nhieu Loc - Thi Nghe Canal after Improvement

Photo by Tran Quang Hung, 2013

1.3.4. Social Aspects

Capital Expenditure

61. Water and sanitation-related diseases are estimated to be responsible for 34 percent of the USD 780 million annual economic impact of

poor sanitation in Vietnam.[12] The remaining 66 percent was contributed by pollution of water resources (USD 287 million), impact on land use value (USD 118 million), time lost to find a location for excretion (USD 41.6 million) and the potential economic impact of lost tourism (USD 69 million).

62. Traditional acceptance of presence of untreated wastewater in the environment is a major challenge in increasing household connection ratios and wastewater charges in urban areas in Vietnam. In most urban areas, wastewater from septic tanks discharges directly into an open drainage system, polluting the environment and generating odor. Whereas people do acknowledge and appreciate the benefits associated with wastewater collection and treatment, only few households are prepared to spend on sanitation beyond providing a septic tank to treat blackwater. Having a clean and convenient toilet and prevention of flooding is among the basic priorities of most households. Most political leaders and local authorities are well aware of the need to prioritize environmental sanitation. However, the sanitation interventions are time consuming to implement resulting in delays to improvements in the environment.

63. **The benefits of public awareness tend to be ignored by most urban wastewater management companies.** Local authorities fund wastewater infrastructure operations and maintenance works from the city budget, retaining the wastewater operating company to act on their behalf. There is often a lack of interest or ownership by the operating company in such an arrangement, and a lack of interest by the operator in the concerns of the consumer since their income is not dependent on payment of water tariffs.

64. **In theory, wastewater operating expenditure (OPEX) should be fully recovered.** The "polluter pays" principle should be followed. In this way the terminology, ''wastewater cost'' or ''wastewater tariff'' is more appropriate than ''wastewater fee''. Information, education and communication programs and monitoring and evaluation of sanitation interventions should be implemented to increase public awareness and appreciation of the benefits of environmental sanitation. However, full O&M cost recovery from the customers would result in tariffs beyond the capacity of many to pay. Recovery of O&M costs should therefore be achieved through a gradual increase in tariff over time, so as not to cause social and economic hardship to the sanitation customers. Moreover, the appropriate choice of less costly technology is critical.

1.3.5. Financial Aspects

65. The main budget source for urban development including infrastructure systems such as transportation, water supply, sewerage and drainage and solid waste management is from ODA in the form of grants, technical assistance and loans. Table 1.3 presents an overview of external assistance for urban development in Vietnam for the period from 1993 to the present. Total funding during this period has been around USD 8.9 billion. During the period 1995-2009, ODA commitments (including loans and grants) to finance drainage and sewerage projects totaled USD 2.1 billion accounting for 8 percent of total ODA loans and grants received in the same period. Most of this amount was disbursed during 2001-2009, and almost half of it during the years 2008 and 2009 (U3SAP report, 8/2012). For urban sanitation projects, the ODA share of a financing package is around 80 percent, with the Government of Vietnam providing around 20 percent. More than 78 percent of ODA funding is loan based. About 50 percent of all financing was disbursed, and the remaining 50 percent committed but not disbursed. The discrepancy between commitment and disbursement is largely related to delays due to government and donor procedures, limitations on contractors' capacity and difficulties in land clearance.

[12] Economics of Sanitation Initiative (Phase 1), WSP, Thang et al, 2007.

Table 1.3 Review of External Assistance for Urban Development, Water and Sanitation Sectors (1993 - to present)

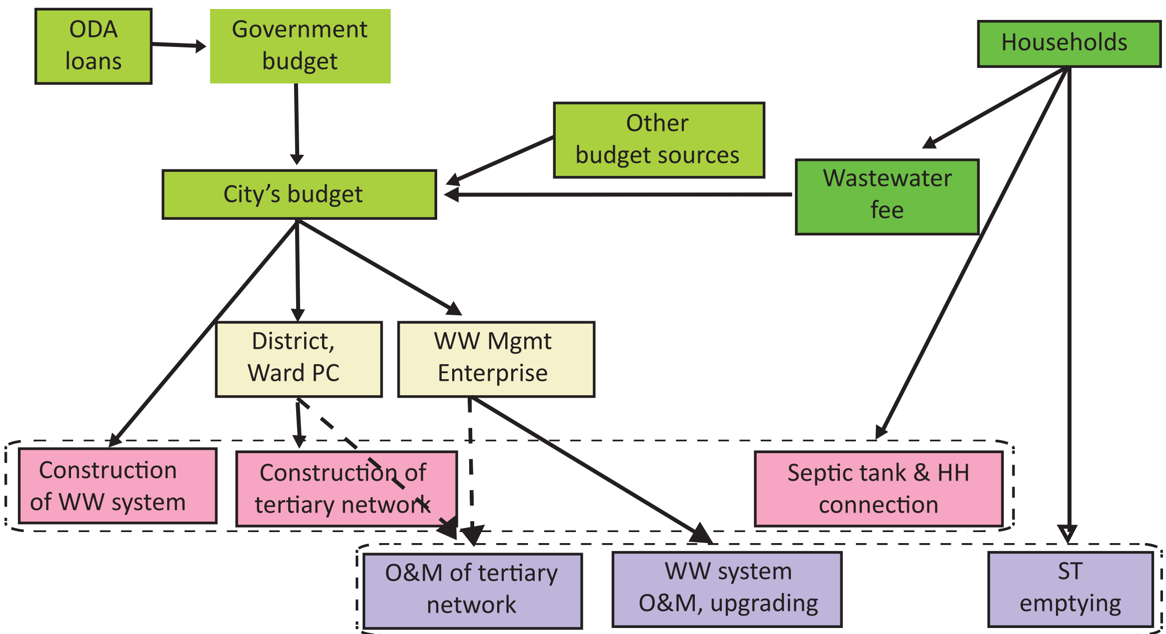
Period	Sources of funding, USD million				Total
	WB	ADB	JICA	Others	
1995 – 2000	333.0	278.9	588.0	209.5	1,409.4
Loans	317.0	270.0	588.0	143.0	
Technical assistance	16.0	8.9	N/A	38.0	
Grants	-	-	N/A	28.5	
2001 – 2010	1,193.1	393.1	1,943.0	829.9	4,359.1
Loans	1,190.0	364.0	1,943.0	593.0	
Technical assistance	3.1	26.0	-	27.9	
Grants	-	3.1	N/A	209.0	
2011 - pipe line	1,150.0	778.7	-	1,203.9	3,132.6
Loans	1,150.0	766.0	N/A	1,090.0	
Technical assistance	-	7.6	N/A	8.9	
Grants	-	5.1	N/A	105.0	
Total	**2,676.1**	**1,450.7**	**2,531.0**	**2,243.3**	**8,901.1**

Source: Adapted from ADB statistics. Donors group meeting at ADB Hanoi office, February 2012.

66. In the absence of a national government-led sanitation program, the dialogue between government and donors is held on a bilateral, case-by-case basis. Currently there is no coordinated government-donor dialogue on sector financing at a high level and there is inadequate coordination among government agencies at central and local levels. This situation does not facilitate effective mobilization of ODA funds and is not suitable for mobilizing sufficient funding to cover the financing needs for sanitation. There is an obvious case for developing a national strategy and a national target program (NTP) for urban sanitation, mirroring the existing NTP for rural sanitation.

67. Since 2006, at least 1 percent of the total state budget expenditure has been devoted to environmental protection activities as required by the Law on Environmental Protection (2005). In fact, this 1 percent of budget expenditure is only part of the expenditure on environmental protection in Vietnam; it only represents the mandatory allocation in the national state budget record included as “state budget current expenditure” under the term of “environmental protection activities.”

Figure 1.12 Sources of Budget for Wastewater System Construction and O&M in Vietnamese Cities

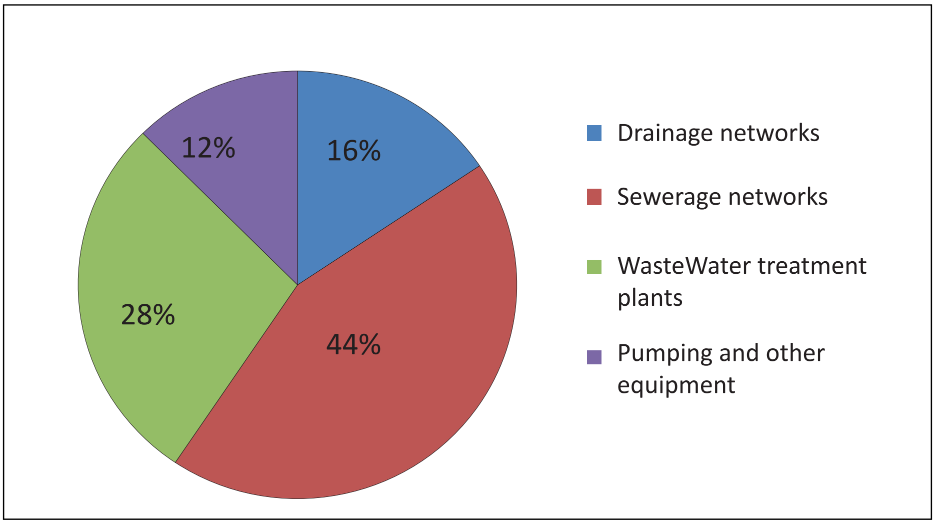


68. **Major local contributions are sourced from central and provincial budgets** for components such as land acquisition and rehabilitation and the tertiary network construction (see Figure 1.12). Generally, the city sewerage and drainage company is only responsible for O&M of the drains and sewers within the street. The tertiary collection network, which is in alleys and residential areas, is the responsibility of local authorities and, in the case of new development areas, of the project owner. Accordingly, the city budget is used to fund O&M expenditure not covered by the wastewater fees collected and for the tertiary network O&M and upgrading through the district and ward authorities. Households invest in their connection to the tertiary network or, in cases where the house is facing the street, a direct connection to the secondary or primary sewerage and drainage network. Households also pay the wastewater fee.

69. The financial sustainability of wastewater systems can be measured by the recovery of operation and maintenance costs through collection of revenue. However, in Vietnam, cost recovery through the collection of fees is at best only a percentage of the actual costs incurred, with significant levels of government subsidy required to support ongoing operations. This trend is expected to continue.

70. A rapid increase in urban population and Government decisions to improve urban services has resulted in increased expenditure on sanitation. In the fifteen year period between 1995 and 2009, about USD 2.1 billion was spent or an average of about USD 150 million per year. The expenditures were on drains, sewers, wastewater treatment plants, and pumping stations as illustrated in Figure 1.13 (also see Appendix A).

Figure 1.13 Estimated Share of Urban Sanitation Expenditures



Source: Hydroconseil, 2010

Operating Costs and Revenue from Wastewater Operations

71. **Revenue from wastewater operations is generated by application of a percentage fee on the water tariff for all water customers,** based either on Decree 67 (revised to Decree 25) or 88. During the site visits conducted to the management of the operational wastewater systems, operation and maintenance cost data was obtained, along with expected revenues. As water tariffs range widely between large cities and provincial cities and towns, the actual amount of revenue received can vary considerably. The environmental protection fees on wastewater shown in Table 1.4 below were representative of the current status of revenue collection in Vietnam, all based on domestic water use (lowest level in a graduated scale).

72. **Actual costs of operation need to be subsidized from local budgets as collection of fees cannot meet O&M costs.** Revenue is collected by the water supply company in its billings to water supply customers, with revenue typically held by the City or provincial level for redistribution to the wastewater enterprises based on agreed annual budgets. Any shortfall in O&M costs is generally subsidized from local budgets. Depending on the local authorities' level of motivation and interest in sustainable operation of the wastewater system, this method either operates very well or marginally in some cases. If budget is only provided for reactive maintenance, then long-term maintenance can be at risk, potentially resulting in early failure of sanitation systems.

73. **Problems are encountered when extraordinary repairs and emergencies arise, for which annual budgets are not available.** At these times, the operating company must seek special approval for funding, which can often lead to delays in repairs, loss of service and can eventually lead to system failure if the problem is not addressed in a timely manner.

Table 1.4 Representative Wastewater Fees from Vietnamese Towns and Cities (2012 data)

City/Town	EP Fee on WW	Basis	Source
Hanoi	VND 348/m^3	10% of water tariff	Hanoi Water Supply Company, 2012
Ho Chi Minh City	VND 480/m^3 [1]	10% of water tariff	Sai Gon Water Supply Company, 2012
Phu My Hung new urban area	VND 930/m^3	10% of water tariff	Sai Gon Water Supply Company, 2012
Quang Ninh	VND 510/m^3 (Ha Long City)	10% of water tariff for Ha Long City, 6% of water tariff elsewhere	Quang Ninh Water Supply Company, 2012
Da Nang	VND 777/m^3	21% of water tariff increasing to 25% (2015)	Da Nang City Authority web-site (2012)
Buon Ma Thuot	VND 200/ m^3 as EP fee or VND 2,800 as water tariff (2012)	Fixed value, less than 10% of water tariff	Dak Lak DOC web-site, 2012
Da Lat	VND 300/ m^3 as EP for non-connected HH or VND 1,000/m^3 (non-connected)	Fixed values, distinguishing connected and non-connected HHs	Lam Dong Water supply and sewerage Co, 2012
Bac Giang	VND 200/ m^3 as EP fee or VND 4,800 as water tariff (2012)	Fixed value, less than 10% of water tariff	Bac Giang province authority web-site, 2012

***Note:** [1] Now revised to VND 770/m^3*

74. Government subsidies and support, however, do not provide effective stimulus for growth and improvement of services in the sanitation sector. For the most part, such subsidies are provided in line with basic budgetary needs, which are more at a subsistence funding level and not designed for expansion or improvement of sanitation services. Currently, the expansion of sanitation services can only be achieved through outside funding provided by international lenders and donors. Local funds are limited and the priority to expand sanitation services is not evident.

75. The level of service provided for sewer maintenance was found to vary widely from an emergency demand response only to proactive routine maintenance. The prevailing condition of the sewerage works was generally consistent with the level of service provided. Operating costs for wastewater systems include O&M for the sewerage collection system, pumping stations and wastewater treatment plant(s). These costs can vary significantly depending of the type of sewerage technology utilized, CSS or SSS-based, the number of pumping stations and the type of technology utilized for wastewater treatment. Highly mechanized WWTPs, which constitute the majority of the installations currently in operation, have higher operating costs as a result of higher power requirements, labor resources and chemicals. The O&M costs for a representative group of WWTPs are compared in Table 1.5 below, highlighting the cost differentials between the technical solutions.

76. The O&M costs shown in Table 1.5 reflect a trend in WWTP operation costs, namely:

a. More complex technologies generally require higher operation costs;

b. Size matters. The larger WWTPs such as Yen So and Binh Hung, despite utilizing more complex technology solutions, have lower costs as afforded by their respective economies of scale;[13]

[13] This remark does not include costs for collection network O&M.

Table 1.5 Comparison of O&M Costs from Currently Operational WWTPs

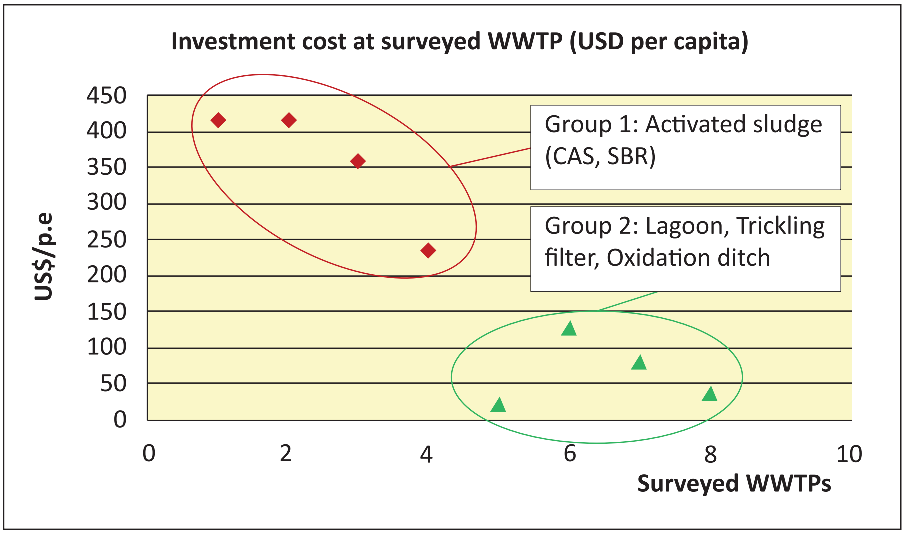
Nr	City	WWTPs	Sewer type	Process type	O&M cost in 2011 (billions VND)			O&M cost (VNDm^3, WWTP only)	Current WW Tariff
					Sewer system	WWTP	Actual cost recovery		
1	Hanoi	Kim Lien	CSS	A2O (AS)	385 billion VND as O&M for whole city sewerage and drainage system, including WWTPs 1, 2, 3	4.7	-	3,070	348 VND/m^3 For Thang Long IP (treated at Bac Thang Long WWTP): 2,400VND/m^3
2		Truc Bach	CSS	A2O (AS)		4.1	-	5,060	
3		Bac Thang Long	CSS	A2O (AS)		7.1	5.1	2,800	
4		Yen So	CSS	SBR (AS)		-	-	4,110 in start-up; 1,686 in current operation (Phu Dien - SFC, 1/2014)	
5	Ho Chi Minh City	Binh Hung	CSS	Aer/Mat Ponds	-	60.823	-	969	480 VND/m^3
6		Binh Hung Hoa	CSS	CAS	-	10.544	-	-	
7		CanhDoi, Phu My Hung area	SSS	Ox. Ditch (AS)	-	-	-	-	930 VND/m^3
8		Nam Vien, Phu My Hung area	SSS	A2O (AS)	-	-	-	-	
9	Da Nang	Hoa Cuong	CSS	Ana. Pond	18.356 billion for whole city sewerage and drainage system	1.295	2010: 17.09 2011: 39.02	118	777 VND/m^3 (21 % of water supply charge in 2012).
10		Ngu Hanh Son	CSS	Ana. Pond		0.782		103	
11		Son Tra	CSS	Ana. Pond		0.859		112	
12		Phu Loc	CSS	Ana. Pond		1.148		196	
13	Quang Ninh	Bai Chay	CSS	SBR (AS)	-	2.918	-	1,830	510 VND/m^3
14		Ha Khanh	CSS	SBR (AS)	-	3.276	-	1,806	
15	Da Lat	Da Lat	SSS	Imhoff Tank/TF	9.706 billion for whole city sewerage and drainage system	-	1.705 (17.6%)	5,139 (w/w collection & treatment); 1,100 (WWTP)	1,000 VND/m^3 for connected HHs (Dec. 88); 300 VND/m^3 for other HHs (Decree 67)
16	Buon MaThuot	Buon MaThuot	SSS	Stab. Ponds	3.938	4.626	2.427 (28.3%)	2,367	200 VND/m^3 (less than 10% of water charge)
17	Bac Giang	Bac Giang	CSS	OCO (AS)	3.936	3.2	-	1,039	200 VND/m^3 (less than 10% of water charge)

c. Simple WWTP technologies generally require lower operation costs; and

d. More complex treatment technologies need to be accompanied by corresponding tariff increases.

These findings are confirmed in the following graphs illustrating investment (capital expenditure, or CAPEX) and O&M (OPEX) costs for all 17 surveyed WWTPs where data was available (**See Figures 1.14 – Figure 1.17**). The OPEX costs in **Figure 1.17** are shown in VND/m^3 to enable O&M costs of WWTPs to be compared with the current wastewater tariff in the same city. Due to limited data available from the survey, costs of investment and O&M for sewerage and drainage components are not shown separately in the graphs.

Figure 1.14 Comparison of Investment Costs (CAPEX) for WWTPs by Group of Technologies

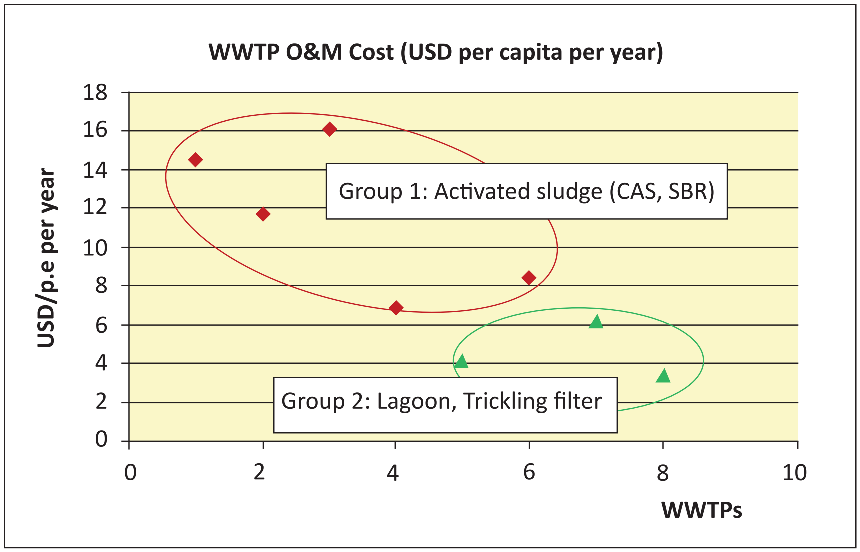


Notes:

- Group 1: Activated sludge (CAS, A2O, SBR) + sludge treatment.

- Group 2: Waste stabilization ponds, Aerated lagoons, Trickling filters, Oxidation ditch + sludge treatment.

Figure 1.15 Comparison of O&M Costs (OPEX, USD per population) for WWTPs by Group of Technologies

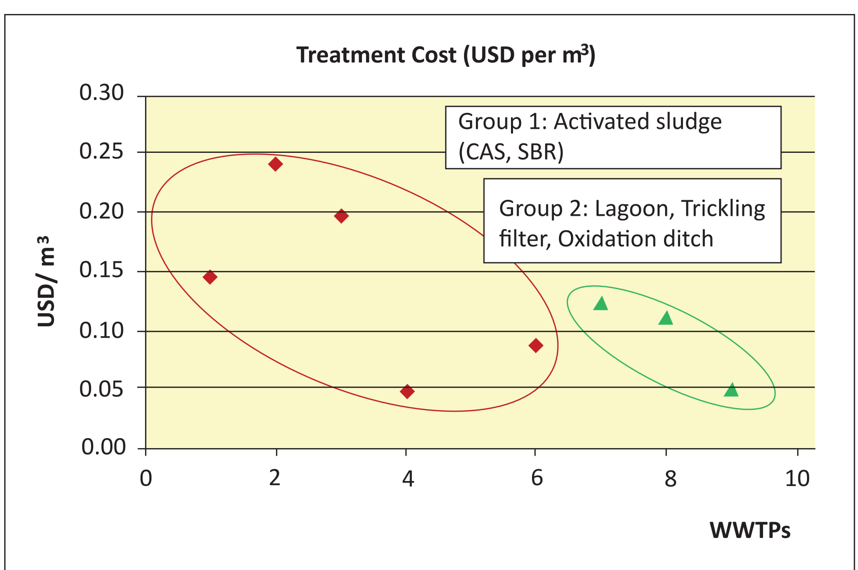


Notes:

- Group 1: Activated sludge (CAS, A2O, SBR) + sludge treatment

- Group 2: Waste stabilization ponds, Aerated lagoons, Trickling filters + sludge treatment

Figure 1.16 Comparison of O&M Costs (OPEX, USD per m³ of WW) for WWTPs by Group of Technologies

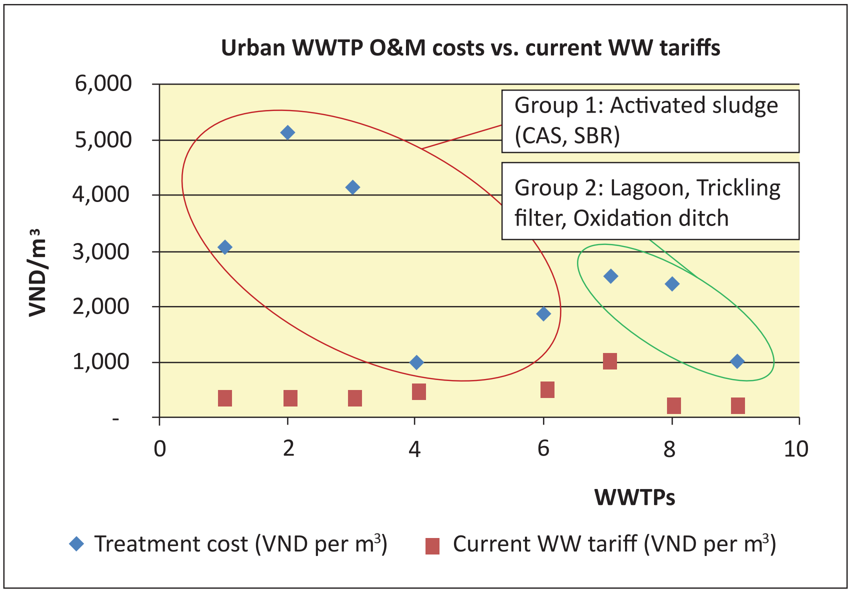


Notes:

- Group 1: Activated sludge (CAS, A2OO, SBR) + sludge treatment

- Group 2: Waste stabilization ponds, Aerated lagoons, Trickling filters, Oxidation ditch + sludge treatment.

Figure 1.17 Comparison of O&M Costs (OPEX, VND per m³ of WW) for WWTPs by Group of Technologies and Current Wastewater Tariff Set



Note:

- Group 1 includes Activated sludge (CAS, A22O, SBR) and sludge treatment;

- Group 2 includes Waste stabilization ponds, Aerated lagoons, Trickling filters, Oxidation ditch and sludge treatment.

77. **Cost recovery is not fully achieved at any of the currently operating wastewater systems in urban areas in Vietnam.** The degree to which costs have been recovered through application of fees, indicated as a percentage of the operating cost recovered, is: 17.6 percent in Da Lat city and 28.3 percent in Buon Ma Thuot city. These numbers were based on available data from representative operating authorities.

78. **Sanitation investments are not a sunk cost; major economic benefits can be enjoyed at an affordable cost.** A recent study conducted by the World Bank Water and Sanitation Program (WSP)[14] showed benefit-cost ratios[15] of 1.4-11.7 for a range of sanitation installations in 17 urban and rural sites in Vietnam. Economic benefits quantified included impacts on health, drinking water, sanitation access time and the reuse of human excreta.

79. **Willingness to charge customers to recover costs is lacking on the part of most local city or provincial authorities.** This was most apparent in the case of Buon Ma Thuot, where the operating enterprise enjoys very positive public opinion regarding the sewerage services offered by the company with households eager to connect once the SSS is expanded in the next phase. However, even with apparent high customer satisfaction, the local provincial government has not taken positive action to increase the rate of cost recovery, choosing instead to subsidize the operating costs from local budgets. In other cities, despite commitment in the Investment Loan agreement to gradually increase wastewater tariffs, most

[14] Economic Assessment of Sanitation Interventions in South East Asia, the Economics of Sanitation Initiative (ESI): a six-country study conducted in Cambodia, Indonesia, Lao PDR, the Philippines, Vietnam and Yunnan Province, China. Water and sanitation Program. January 2013.

[15] Benefit-cost ration is defined as economic return per dollar invested.

local authorities do not comply. This lack of willingness to charge could be linked to a system which has historically been State managed with deficits subsidized. Pressure on local budgets, together with an increasing need for improvement in wastewater collection, treatment coverage and service quality may change this view but this will take time and political will to achieve.

Private Sector Investment

80. **Private sector investment in wastewater collection and treatment as a component of urban development projects is a new trend in most of cities in Vietnam.** Even where centralized WWTPs have not been constructed by the city authority, effluent standards for domestic wastewater discharged to combined drains require all owners of hospitals, commercial establishments, apartments and hotels to treat wastewater to meet Class B, QCVN 14:2008/BTNMT. This requirement is also applied to new urban developments. As of August 2012, there are about 800 new urban development areas registered in Vietnam with a total area of 120,500 ha (MOC, 2012). Revenue collected based on application of a wastewater surcharge on the water bills (10 percent in most of cases), will not cover investment and O&M costs for the wastewater collection and treatment systems.

81. **Although private sector investment in sanitation can reduce the budget burden on Government, often this is not considered in the city sanitation planning.** Although the current tariff and regulatory regime for sanitation systems is not attractive to the private sector, there are examples of private sector participation in the sector. Failure to consider these initiatives results in duplication of facilities. For example, an investor VinGroup has been required to build a 2,700 m^3/day WWTP for a new urban development project named Times Cityin Hanoi. Treated wastewater will be discharged to a combined sewer which drains to Kim Nguu canal where, a short distance downstream, wastewater from Kim Nguu canal is pumped to the 200,000 m^3/day centralized WWTP Yen So. The same investor is constructing a new WWTP with capacity 4,500 m^3/day for their other new urban development project of Royal City in Nguyen Trai Street, Hanoi. This WWTP is located in a sub-basin draining into the 270,000 m^3/day Yen Xa WWTP but has not been considered in the design of this facility.

82. **Conversely, urban developers often delay construction of their wastewater treatment components, trying to minimize capital and operation expenditures.** There are few WWTPs for new urban development areas that have been built and are in operation in Vietnam. Good examples of this model are Canh Doi WWTP (10,000 m^3/day, operation started in 2007) and Nam Vien WWTP (15,000 m^3/day, operation started in 2009) built and operated by the Phu My Hung new urban area developer in Ho Chi Minh City. A separate wastewater collection network, with 90 percent household connection coverage and with two operating WWTPs, contributes to a quality living environment in Phu My Hung which is considered one of highest standard new urban development areas in Vietnam. Treated wastewater is reused for irrigation of green spaces and landscaping and sludge is utilized for fertilizing trees. Total investment cost for the two WWTPs which achieve a Class B, QCVN 14:2008 effluent standard is USD 5.8 million (*Source: Phu My Hung JVC web-site).*

83. Other potential modalities of private sector participation in the wastewater sector are under Build Operate (BO), Build Transfer (BT), Build Operate Transfer (BOT), Design Operate (DO) and Design Build Operate (DBO) types of contract. The investor finances all or part of the cost of the wastewater collection and/or treatment systems with the expectation of a return on their investment, although most investors expect to receive land under favorable conditions for housing and other business developments. Examples of these modalities are West Lake WWTP (Hanoi, BT project, Phu Dien Company), Yen So WWTP (Hanoi, BT project, Gamuda Company) and the proposed wastewater collection and treatment project in Da Nang city (BO project). It is too early to comment regarding the success or failure of these projects.

2. Sector Performance Analysis

2.1. Drivers and Barriers

84. This section provides a broad listing of drivers and barriers that impact upon the scaling up and improvement in quality of urban sanitation services. This broad list approach is taken to highlight the many opportunities and challenges faced in the growth and improvement in urban sanitation services in Vietnam. The sub-sections below will discuss selected key drivers and barriers in greater detail, providing specific examples of how these have influenced the sanitation sector in Vietnam.

2.1.1. Key Drivers for Scaling up of Urban Sanitation

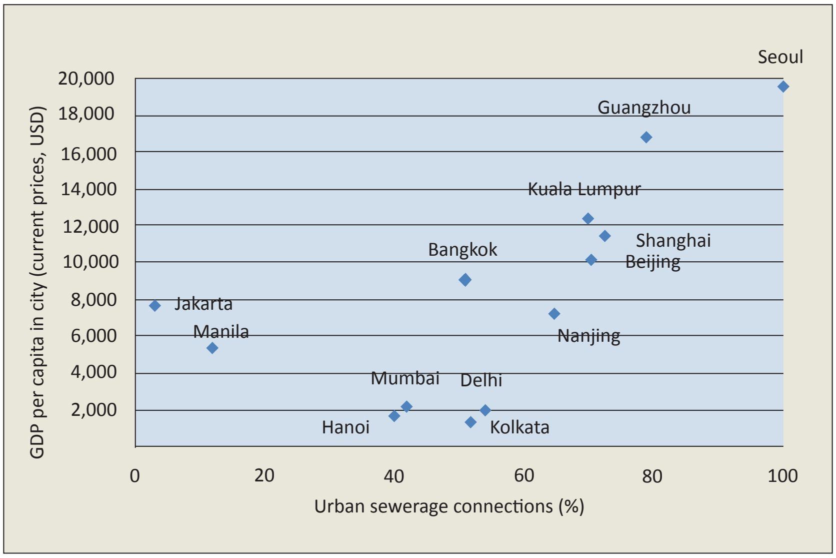
Establishment of a Strong Institutional and Legal Framework

85. Presence of a strong institutional and legal framework is critical to effectively scale up urban sanitation. Roles and responsibilities for urban and rural environmental sanitation have been established among line ministries. A set of laws and relevant documents have been developed aiming at the establishment of a strong legal framework and enabling resource allocation for sanitation improvement activities. Moreover, a flexible adaptive approach is applied whereby legislative documents are being revised and updated regularly. For the wastewater sector, the most important laws and related legislative documents include: Politburo Instruction No. 36/CT-TW of 1998, Politburo Resolution No. 41/NQ-TW of 2004 and Politburo Instruction No. 29/CT-TW of 2009 on environmental protection in the industrialization – modernization period of the country, Law on Environment (issued 1995, revised 2005), Law on Water Resources (issued 1998, revised 2012), Effluent Wastewater Standards (first issue was in 1995, updated and amended frequently), Decree 88/ND-CP-2007 (revised in 2012), and Decision of Prime Ministry No. 1930 on Orientation for Urban and Industrial Sewerage and Drainage for the period 2030, with vision to 2050. Based on targets (although they are very ambitious) set out in these documents, concrete programs and projects are being developed and implemented.

Demand from the Public, Increased Awareness, and Intolerance of Pollution

86. Peoples' aspirations to improve their quality of life are also a strong driver. As income levels increase and basic needs are met, people expect a better quality of life and environment in which they live. Figure 2.1 below illustrates the correlation between GDP in a city and the percentage of the urban population with a sewerage connection. Cities in East Asia are engines of economic growth. As they continue to develop economically, income levels will rise, leading to demand for a better environment.

Figure 2.1 Urban Sewerage Connections against City GDP per Capita



Source: World Bank, 2013

87. **Public opinion expressing displeasure with the status quo regarding pollution can be a strong driver of government policy.** This can have a positive impact on decision-makers to take action to avoid criticism of being ineffective in terms of resolving critical environmental problems. The evidence of wastewater pollution is everywhere in urban areas of Vietnam, such as blocked drains and drains with odors in neighborhoods, foul-smelling drainage canals and rivers, which have effectively become horizontal septic tanks and are the ultimate depositories of the city's wastewater. As the standard of living improves in these urban areas and the resident population becomes better informed by IEC campaigns focused on sanitation issues, the public will begin to demand improvements in their urban environment. IEC campaigns have been effective in the sanitation projects at Dalat and Buon Ma Thuot in promoting and gaining public support for improved sanitation as well as generating enthusiasm and public demand for expanded coverage in subsequent projects. These campaigns were crucial in the public acceptance (and involvement) in the most critical aspect of these projects, the connection of households to the public sewerage network.

Household Wastewater Disposal

88. Many households in urban areas of Vietnam lack on-site disposal options as they have limited footprints and are underlain with poor percolating soils. These conditions place significant pressure on households with regard to disposal of on-site generated wastewater, particularly if connection to a combined or separate sewerage system is not available. Disposal from on-site sanitation such as septic tanks can result in contamination of the groundwater, the soil, and eventually overloading of the disposal system. These problems are often worse where the soils are slow percolating. The lack of proper disposal options will place pressure on local authorities to provide a public system for sewage collection and disposal and has prompted the authorities to implement a program for construction of tertiary CSS drains in many small lanes as is currently underway in Hanoi. The need for household sewage disposal is a fundamental driver for the implementation of public sewerage systems, be they combined or separate collection systems.

Access to Sources of Funding

89. **Access to sources of funding is undeniably a strong catalyst in the development of sanitation programs.** Cities and towns currently served by urban wastewater systems (sewerage + treatment) all share the common characteristic of having had access to funding, either as grants or low-cost loans, typically provided by international donors , allowing the recipients to carry out sanitation projects that would have otherwise not been financially possible. Local (counterpart) funding may be available to support 10-20 percent of the project costs but self-funding of projects cannot yet be carried out without a significant funding input from the central governments.

90. Compulsory treatment of wastewater and good living conditions to attract clients are important drivers for the project owner to invest in sanitation infrastructure. For new urban development areas with private investors, self-finance or commercial loans are the most common type of funding for construction of the infrastructure system including wastewater collection and treatment. Exchange of land for making investment in WWTP facilities, as in the case of the Gamuda-developed Yen So WWTP project in Hanoi, is also a new driver for increased funding of sanitation.

2.1.2. Drivers for Improving Quality of Urban Sanitation Services

Ownership (and Capacity) of Local Authorities

91. **Local authorities play a pivotal role in the development and long-term management of urban sanitation services.** Local authorities who display a strong sense of ownership, based on the capacity of management and operations staff and the commitment to providing quality services, have been shown to have significant impact on improving the quality of urban sanitation services. In some surveyed cities such as Da Lat and Buon Ma Thuot, that sense of ownership was evident to a high level, with positive improvements in the quality of sanitation services. Conversely, in some other visited cities, there was a lack of commitment or interest on the part of the local authorities in terms of how services were being provided. Budgets were insufficient, resources were limited, and the staff lacked incentive to improve the services provided.

Commitment to OPEX by Local Authorities

92. A commitment to supporting O&M costs by the local authorities can be a strong driver for improvement to the urban sanitation services offered. Recovery of O&M costs has not yet reached financial sustainability in Vietnam. Low cost recovery is primarily due to the lack of a suitable tariff framework, unwillingness of the customers to pay a sustainable tariff and of local authorities to charge. Normally, wastewater fees collected as part of the water supply bill are sufficient to recover only 20-30 percent of the actual O&M costs. Thus, it is imperative that local authorities commit to providing financial support for the balance not covered by the collected fees. This commitment must be at a sustainable level and be inclusive of the costs for both routine and emergency repair and maintenance. Sufficient budget to carry out proactive O&M will keep the operational readiness high and create improved effectiveness in the sanitation services provided.

2.1.3. Barriers for Scaling up Urban Sanitation

Lack of Priority by Local Government; Top-down Approach

93. Local authorities have to prioritize expenditure from their limited budget for a range of activities, including environmental sanitation. The majority of provinces, on the other hand, are subsidized for

infrastructure development from the National budget. The lack of a committed counterpart investment from local authorities for ODA loans or grants will usually lead to delays in implementation. Furthermore, inadequate O&M activities not following accepted procedures can lead to system failure and affect project efficiency and sustainability. This is essentially a top-down approach to development which limits mobilization of potential resources and participation from stakeholders such as households and the private sector as well as local government. It can also negatively impact on key factors within the community such as household connections and willingness to pay for the wastewater service.

Slow-moving or Ineffective Bureaucracy

94. The rate at which urban sanitation projects are implemented is directly impacted by the effectiveness of the local executing authority. Slow decision-making processes and ineffective management from the executing agency is a barrier to the scaling up of urban sanitation. In Vietnam, there are only 17 wastewater systems (inclusive of WWTPs) in a country of over 87 million inhabitants. Although the number of wastewater systems is expected to grow significantly over the next five years as capacity to manage these works improves, historical evidence shows that limited efficiency and effectiveness of local authorities is a significant barrier to the performance of the sanitation sector. With projects now taking from five to ten years for implementation, from concept to commissioning, there is room for significant improvement.

Lack of IEC and Public Awareness

95. There continues to be a lack of adequate IEC approaches. This limits public awareness of the benefits of sanitation and has the potential to inhibit the scaling up of the sanitation sector. This could best be demonstrated by the Bac Giang WW project, where limited IEC was conducted during implementation thereby creating little public awareness and no ownership or commitment on the part of local authorities. Where projects have included IEC campaigns, these have played an important role in garnering public support for urban sanitation projects, particularly with respect to socially-sensitive issues such as the implementation of household connections

Unplanned City Development and Lack of Master Planning

96. **Some provinces are implementing wastewater projects in the absence of city plans and drainage[16] and sewerage master plans**. As a result, these projects have faced difficulty in wastewater system selection, zoning and phasing of project stages, prioritizing of household connections, the sewerage network and the treatment plant components. In some cases, technology options were not foreseen at the planning stage, such that land was not reserved for the wastewater treatment plant sites, inclusive of a buffer zone. Furthermore, sanitation planning at the provincial level has encountered difficulty due to inadequate inspection resources and local authorities' failure to penalize violations when local residents make illegal connections to sewers and canals. Failure to control urban development that does not follow approved development plans creates greater difficulties. Legal requirements for the formulation and approval of sanitation planning need to be issued, which should serve as the basis for urban development and urban management at both the central and local levels.

Household Connections

97. **The failure to achieve a higher rate of house connections is a significant barrier to the development of the sector.** House connections are critical to the effectiveness of both combined and separate systems. While 60 percent of households have direct or indirect connections to a public sewerage or drainage system,

[16] Currently drainage plans have been prepared for 10 provinces.

this is primarily in the central urban districts of the cities in Red River and the Mekong delta. Elsewhere, the connection ratio is still low, particularly in low density towns and peri-urban areas and in central cities which are situated on sandy soils with high percolation properties. House connections can be perceived by the implementing local authorities as problematic, where they represent a potentially home-invasive activity in which rerouting and/or replacement of sanitary piping within the household may be required. Local authorities are often unwilling to carry out these tasks as they understand that there may be political repercussions.

Figure 2.2 Flood in Hanoi city in October 2008

Source: vnexpress.net

2.1.4. Barriers for Improving Quality of Urban Sanitation Services

Fragmentation of Responsibilities for O&M and Limited Stakeholder Coordination

98. **Fragmented responsibilities among stakeholders limit coordination and efficiency of the invested resources.** Some urban sewerage and drainage public works companies only conduct O&M activities according to ''minimum requirements'' due to the limited capacity of the operator and lack of compensation from the local government. Fragmentation is an issue in most cities in which household connections and the tertiary network are the responsibility of the community and local authority management, whereas the urban wastewater company is responsible for the main trunk sewers and WWTP. Residents in the sewerage service area who are not satisfied with the quality of service are also less willing to pay, but with fragmented responsibilities it is not always clear who is responsible for the service failure. Furthermore, in some cities, responsibility for O&M of the drainage and sewerage network and O&M of pumping station and WWTPs fall under different public utilities. Reuse of wastewater and sludge is not considered in most sanitation plans and is not controlled by any organization.

Limited Capacity of Local Stakeholders

99. Limited capacity of the project management unit (PMU) staff, local contractors and other players involved in wastewater project activities is very common. Limited capacity in project management is demonstrated by delays in carrying out site clearance for construction, inefficiencies in managing and monitoring contractors, weak project financial management, poor knowledge of the procedures of basic construction and limited knowledge of the bidding processes in Vietnam and of the donors. Weaknesses of contractors, including design and build contractors, leads to limited quality of construction works or worse, failures. The lack of adequately trained technical sanitation personnel is an important challenge for effective O&M. Furthermore, a fundamental weakness which precedes these implementation issues is the short-sighted approach to urban planning, including the wastewater components, which may result in serious failures and lead to expensive lessons in the planning and implementation of wastewater projects.

2.2. Issues Affecting the Sanitation Sector

100. **This section discusses some key issues which currently affect the sanitation sector in Vietnam.** The key issues include the selection and application of appropriate WWTP technology, the type of sewerage systems (combined versus separate) adopted, household connections, effluent standards, cost recovery, septage waste management, and appropriate organization models for wastewater collection and treatment. These are issues faced at different stages of wastewater planning and project implementation as well as during system operation and maintenance.

2.2.1. Wastewater Treatment Technology

WWTP Performance

101. The concentration of pollutants received at WWTPs from CSS is very low, although many of these plants are designed for much higher loading. Combined sewerage systems are responsible for the collection and conveyance of wastewater to 13 of the currently operating 17 wastewater treatment plants (WWTPs) in Vietnam, amounting to a total design flow of 552,000m^3/day. Based on monitoring reports from each of these 13 WWTPs, the concentration of pollutants (BOD, COD, SS, N, P) coming into treatment plants is very low (see section 1.3.2). Of these 13 WWTPs receiving CSS-based flow, eight WWTPs with total capacities of 406,000m^3/day utilize some form of activated sludge technology (CAS, AO, SBR, OD) which has been designed for much higher loadings of organic and other parameters than is currently received. With the applicable effluent standard for seven of these eight WWTPs being governed by a limit of 50mg/l for effluent BOD, it raises the question of why these wastewater systems use highly technical solutions for treating wastewater where effluent standards may have been met with low cost options. This highlights the ineffective use of investment capital in making choices regarding wastewater treatment technology.

Figure 2.3 Bac Giang Wastewater Treatment Plant

Photo by Nguyen V. A., 2012

102. **For systems with dilute influent, an alternative approach may be to construct an advanced primary treatment plant**. An advanced primary treatment system, utilizing a chemically enhanced primary treatment process, could accomplish quite acceptable results and be easily adjustable for turndown, based on seasonal changes to the influent characteristics. Such a facility would be less costly to construct and operate, thus saving investment capital for other projects and reducing the economic burden to the

end users. This type of initial treatment works would be compatible to expansion by use of secondary treatment should the effluent standards or influent organic loading conditions change.

103. One solution for wastewater management in coastal cities, such as are prevalent in Vietnam, is discharge of primary treated effluent to sea through a submarine outfall. In international practice a number of countries such as USA, Colombia, Australia are applying marine outfall technology. Since Vietnam has a focus on protection of coastal biodiversity, development of tourism as well as aquaculture along the coast, this might require a special study to consider where and how this technology can be applied. Modification in the effluent quality standards with specific norms for submarine outfalls would also be needed.

104. **There are WWTPs in operation in Vietnam using low-cost wastewater treatment technologies.** Examples are the waste stabilization pond system (Buon Ma Thuot, Binh Hung Hoa) and the Imhoff tank – Trickling filter and Maturation Pond (Da Lat). There are also some on-going projects that have selected this approach for the entire plant, or for at least the initial project stage. Examples are the waste stabilization pond and constructed wetland (Thanh Hoa), the aerated lagoon and constructed wetland (Quang Binh), a CEPT and Trickling Filter (Binh Dinh), a primary clarifier (Soc Trang and Tra Vinh), and an aerated lagoon (Chau Doc, An Giang and Phan Rang - Thap Cham, Ninh Thuan).

Analyses and Discussions

105. There are a number of factors that have influenced and will continue to influence decision-making regarding selection of wastewater technology in Vietnam, namely:

- Application of the effluent standards in the design of treatment facilities has not in the past considered the receiving water body sensitivity or the potential use of the effluent. This creates the justification for the use of costly highly technical treatment solutions and eliminating potentially more favorable, appropriate solutions.
- Overly conservative approaches in planning and design can lead to overdesign of WWTP facilities and the selection of technologies that are not the most appropriate for the application. The activated sludge WWTPs are often designed based on typical influent BOD loading of 200 mg/l, but in reality are receiving flow with influent BOD averaging between 31 and 135 mg/l, thus resulting in excess capacity and ineffective investment expenditure.
- Local authorities entrusted with decision-making on technical matters generally lack capacity to understand these matters and therefore may take non-economical decisions. There is also the tendency for local authorities to look at what is being done for urban sanitation in other cities and follow a “popular” choice, irrespective of whether it is appropriate for the local site conditions or application.
- Implementation of wastewater projects without prior sanitation planning and lack of strategic vision in urban planning creates serious difficulties when identifying available land for low-cost wastewater treatment options. Without reservation of appropriate public land for WWTPs in future stages, local authorities often prefer to select options requiring less land to mitigate economic and social problems associated with land acquisition, land clearance and rehabilitation.
- Local authorities often view wastewater technologies as status symbols, representative of their city’s stature in Vietnam. Highly technical solutions are viewed as better reflecting the “modern” status to which some of these cities aspire. Simpler and more appropriate technologies are viewed negatively, are considered obsolete and are rejected for consideration as they don’t meet the perceived image of the City, as viewed by the decision-makers.

106. **How can the sanitation sector in Vietnam be refocused to select more appropriate technologies for wastewater treatment** that are more responsive for the local conditions, as well as being more affordable in terms of long-term operations and maintenance? Selection of the most appropriate treatment technology involves the technical evaluation of the following key criteria. Based on the evaluation of each option with regard to the criteria below, a quantitative ranking for each option can be prepared.

- *Land Requirement.* In provincial cities and towns, consideration could be given to transfer of the collected sewage beyond the confines of the urban city area, extending into the surrounding agricultural areas. These outlying areas will not have the constraints associated with residential populated areas and land can be acquired in greater amounts and at lesser unit cost. Given that low-cost technologies often require a larger footprint, reservation of an appropriate land area for future stages of WWTPs should be foreseen in urban sanitation planning.
- *Operations and Maintenance Cost.* Operations and maintenance cost is another important parameter in the evaluation process. What will become readily apparent in this analysis is that increased technical complexity will generally result in increased O&M costs. These O&M costs are critical to the long-term financial sustainability of the operations, and as such, should be considered to be an important parameter in the ultimate selection of the treatment technology.
- *Investment Costs*. Investment costs are estimated based on preliminary sizing of each treatment technology option being considered. To objectively evaluate treatment options, a decision matrix can be utilized to assign a quantitative value for each technology option. Selection of the most appropriate technology should be based on the least cost option that can achieve the performance requirements and be constructed on the land available for development.
- *Suitability to Achieve Discharge Requirements.* Based on the applicable discharge standards, technologies which can achieve the prescribed standards must be determined. A range of options can be considered from suspended solids to attached growth biological treatment, from conventional biological wastewater treatment to natural treatment processes. The current regulations regarding effluent standards create barriers in this regard, as the nutrient standards prescribed may be difficult to achieve with the use of simpler technologies than conventional ones.

107. **Decentralized wastewater management is also an approach enabling the application of low-cost wastewater treatment technologies.** Small wastewater collection and treatment systems can be implemented in stages, aiming at control of small flows. However, there are some drawbacks with the decentralized systems: the unit costs for investments and operations is normally higher compared to centralized wastewater treatment plants; and the institutional arrangements for centralized systems are often more effective, compared to decentralized systems, leading to sustainable operations. These factors have to be taken into account while considering decentralized systems.

2.2.2. Combined Versus Separate Sewerage Systems

108. This section explores the significant differences between the combined and separate sewerage systems utilized in Vietnam which is summarized in Table 2.1 below.

Table 2.1 Combined versus Separate Sewerage Systems in Vietnamese Cities

Description	Combined SS	Separate SS
Percentage of Coverage in Vietnam		
• Currently (design flow)	92%	8%
• In progress (design flow)	98%	2%
Influent BOD (annual avg.)	Avg. 67 (min. 31, max. 135) mg/l	Avg. 358 (min. 336, max. 380) mg/l
Influent BOD (flow-wt avg.)	53 mg/l	359 mg/l
WWTPs served		
• Currently	13	4
• In progress	29	3
WWTP with Activated Sludge Tech.		
• Currently	8	2
• In progress	22	3
WWTP with Low/Med Tech.		
• Currently	5	2
• In progress	7	0

System Performance

109. **Combined sewerage systems have been the traditional and historical method for sewage collection in Vietnam.** This approach is being continued in the wastewater projects now in progress. The reason for this is related to both cost, as CSS is less costly, and to the ease of implementation, as CSS can be implemented with far fewer pipelines creating less construction impact in residential neighborhoods. Furthermore, CSS generally utilizes the existing drainage system as secondary sewers for collecting wastewater from the household, making it necessary only to intercept that flow by use of combined sewer overflow structures (CSOs) and then transport that flow to a WWTP for treatment. To date, a formalized program for household connections is generally excluded from the implementation of CSS, again making it more attractive to decision-makers due to the apparent simplicity of execution.

110. This combined flow of sewage and drainage results in very dilute organic loading to the downstream WWTPs due to several factors, namely:

- Households connected to the CSS generally utilize on-site septic tank treatment systems which remove approximately 30 - 40 percent of the BOD (Nguyen V. A., 2007) prior to this flow being discharged to the CSS;
- CSS in residential neighborhood catchments are typically constructed as flat-bottomed, rectangular covered channels having little or no slope with open joints that allow significant infiltration of typically high groundwater levels as well as enhanced decomposition processes by bacteria existing in the drains and in the soil;
- CSS by design, and by primary function, are intended to collect rainwater runoff (drainage) from city streets and public areas; and
- The low organic content of CSS-based wastewater may mean that treatment is not necessary or at least that only simple treatment processes are required.

111. The use of CSS is governed largely by economics, as the investment cost is typically lower than would be if separate drainage and sewerage systems were constructed. Normally, residential development follows the construction of basic infrastructure, roads, drainage, water supply, electrical power, with sewerage traditionally being combined with the drainage system out of necessity and to save costs. Only with new residential areas is the concept of separate sewerage collection being applied as mandated by government decree. However, these new residential areas are generally in outlying areas, with the SSS collected flow then conveyed later by CSS to downstream WWTPs for treatment.

112. Separate sewerage systems (SSS) are designed to collect and convey only sewage, with drainage and rainwater specifically excluded. Such a system can offer very significant benefits to the end user, in that household septic tanks can be eliminated and households can be connected directly to an enclosed piping system which is not impacted by either solid waste or rainfall. Neighborhood odors long associated with CSS can be effectively eliminated with SSS. The quality of the wastewater collected and transported to the WWTP is strictly limited to household sewage and, as such, is of high organic load concentration. For SSS, the amount of flow collected and pumped is less, allowing downstream WWTPs to be designed with lesser capacities. In terms of investment cost, the SSS will be more costly than CSS, as three systems of piping, primary trunk mains, secondary sewers (located in streets) and tertiary sewers (located in sidewalks) will be required. However, the investment in SSS results in the inherent advantages mentioned earlier. The use of separate sewer systems should not be overlooked for consideration during sanitation planning as the benefits to the end user are significant.

113. **Separate sewerage systems are effective in collecting more highly concentrated sewage.** This is because direct connections are mandated thereby excluding rainwater runoff and drainage from the system. The quantity of sewage collected in a SSS is therefore far less than in a CSS. This basic concept difference facilitates the design of a smaller diameter collection network, smaller sized pumping stations and smaller trunk mains for conveyance of the collected flow to a smaller (hydraulically) sized WWTP. However, separate sewerage systems (SSS) are utilized in only 4 of the 17 urban wastewater systems in Vietnam, namely: Da Lat, Buon Ma Thuot, Canh Doi and Nam Vien (both the latter are in Phu My Hung area, HCMC). Influent BOD concentrations as measured at the Da Lat and BMT WWTPs are significantly higher than that of the CSS based systems.

Analyses and Discussions

114. **Increased public awareness of health and hygiene is a major driver in garnering public support for carrying out sewerage works.** If people understand the benefits offered by a direct connection of their household wastewater (without use of septic tanks) to the SSS, as transported in a fully enclosed and odor-free method, they would have greater support for SSS. However, local authorities in general perceive little value in “software aided” solutions, such as offered by IEC programs, instead only focusing on the hardware component of infrastructure.

115. **Households must have a means to dispose of their wastewater generated on-site.** This is perhaps the most critical driver to scaling up construction of sewerage works in any neighborhood, particularly those having poorly draining underlying soils and restrictive lot sizes. This urgency has led many households to connect to existing drains in an ad hoc manner, without proper guidance or inspection, leading to poor connections and impact to downstream CSS-based delivery systems.

116. **Benefits to customers will vary depending on the specific type of collection system utilized.** Customers served by CSS will benefit from household connection to the local CSS, which will likely be

an existing covered drainage channel. There will be no reduction in odors, which may possibly increase, as more household connections are made to the public drains. The customers may benefit by reduced nuisance conditions and odors from downstream drainage canals and rivers if the CSO-diverted flows to the interceptor sewers reduce the organic content entering these watercourses. The environment will benefit from the treatment of the collected wastewater.

117. **Customers served by SSS will receive significantly greater benefit,** the most important being that an on-site treatment system (septic tank) is no longer required and can be bypassed or removed, once the household's sanitary piping is connected to the SSS. The household connection to the public sewer will be through a junction box, which will provide access to both the private and public sewers for maintenance, another benefit to the customer. As the SSS is a totally enclosed piped network designed to hydraulically convey collected flow at velocities which prevent sedimentation, there will be little or no odors in the service areas, and in fact, in the entire network extended to the WWTP. Thus, the environment of the immediate neighborhood and the service area as a whole will be noticeably improved in terms of odor mitigation.

118. **CSS require a number of considerations in design, construction and O&M.** Inclusion of solid waste and presence of odor at manholes may create performance failure and poor acceptance from the public. Lower flows during dry weather flow create increased solids accumulation in sewer lines, which requires an appropriate O&M regime. High flows in the rainy season may create overloading and flooding at sewer lines, pumping stations and the treatment plant.

119. **Cost is often the overwhelming factor for selection, favoring the CSS-based systems.** However, selection based on investment cost alone does not take into consideration the advantages of SSS. Selection is also based on the misconception that household connections are only required if SSS is utilized and that CSS can be operated effectively without household connections. For off-site disposal, sewage discharge from households must be connected to a public sewer system, irrespective of whether it discharges to a drainage system (CSS) or a separate sewer system (SSS). Thus, the argument that the selection of CSS will eliminate the need for household connections is incorrect.

120. When considering selection of either CSS or SSS, the cost of the septic tank, which is an integral part of the CSS, must be taken into account. Average investment cost for construction a of septic tank and household connection to the city sewer is USD 250 per household, or USD 55.6 per capita (*Nguyen V. A. et al, ESI-2 study, 2012*). This cost does not include the fee for septic tank emptying, which is estimated to be as much as USD 34 - 51 per household, or USD 7.5 – 11.3 USD per capita per every five years (*Nguyen V. A. et al, FSM study, 2012*). Those costs should be included in the financial analysis during selection of urban wastewater collection and treatment systems.

121. The design intention of Combined versus Separate Sewer System technologies can be compared in Table 2.2 2 as follows:

Table 2.2 Main Design Features of CSS versus SSS

Description	Combined SS	Separate SS
Inclusion of Rainwater	Yes	No
Volume of Flow Collected	High	Low (80% of WSC)
Inclusion of Solid Waste	Yes (Unavoidable)	No
Household Connection Required	Yes	Yes
Septic Tank Required	Yes[1]	No (Optional)
Odor Generation Potential	High	Low
Access for Maintenance	Poor	Good
Investment Cost	Medium	High

Note: *[1]A well designed combined sewerage system can operate effectively without pre-treatment by septic tanks. However, the existing drainage systems in Vietnamese cities which convey the combined sewage have not been designed to prevent deposition of solids, with the resulting odor generation. Hence pre-treatment through septic tanks is an essential pre-requisite for combined systems in Vietnam that utilize the existing drainage system.*

2.2.3. Households Connections

122. It is estimated that 60 percent of the households located in urban areas are connected to public sewerage or drainage systems of some kind. The rate of connection varies from city to city depending on the density of the residential development and the underlying geology, as this will impact whether or not the household can dispose of the wastewater on-site by means of percolation into the soil. In Da Nang for instance, the underlying soils allow on-site percolation of the household-generated wastewater. For this reason, the house connection rate in Da Nang is low (less than 10 percent), as is the average BOD concentration in the wastewater collected in the combined sewerage system.

123. **The motivation for residents to make a household connection is first and foremost, one of disposal.** When specific site conditions preclude on-site disposal, such as is the case in Hanoi, Hai Phong and HCMC, then the household must find a way to dispose of wastewater off-site, typically to the nearest drain which is generally located in front of the house along the sidewalk/street interface. The manner and quality by which the house connections are achieved is variable, as the majority of connections are made informally by the household or by a hired contractor, generally without permit or inspection by the operating authority.

124. **House connections to public sewerage systems are an essential component to any complete wastewater system,** no matter whether the wastewater is collected by means of a combined or separate sewerage system, as the households contribute the majority of organic loading to the downstream sewerage system. In Vietnam, the use of combined sewer systems dominates. The low organic loadings measured at downstream WWTPs in CSS-based systems highlight the aspect of poor household connections and high dilution by drainage water collected in these combined sewers.

125. **Household sanitary piping in existing SSS such as in Buon Ma Thuot often has been installed improperly.** This relates to the need for water traps on all sanitary fixtures and floor drains to prevent odor problems and the need for a vent stack for venting sewage generated gasses. Making proper household connections may therefore also require the renovation of earlier, poorly installed household plumbing

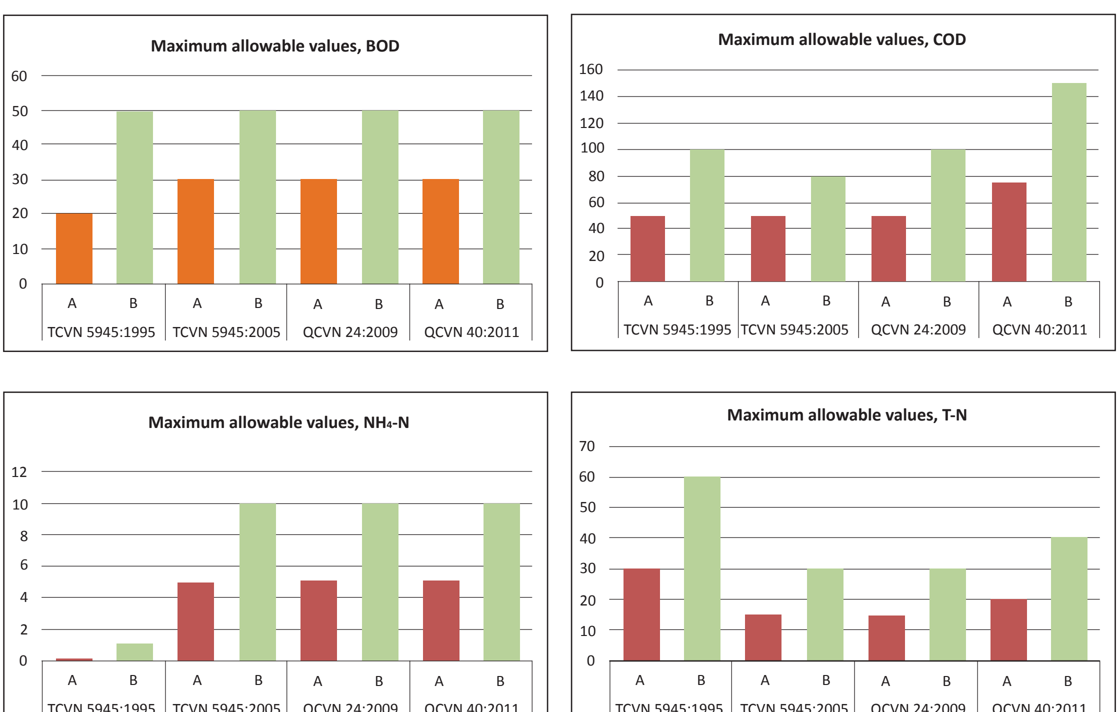
at an expense to the householder. Household connections should incorporate a clear point of interface between the private and public systems in the form of a small junction box installed in front of each house as the final component of the public system. The household connects the discharge piping directly to the junction box which then conveniently becomes the access point for maintenance of both the private and public piped networks.

126. **The role of household connections in Vietnam has been historically misunderstood.** Connection of the household sanitary piping to public sewerage systems in Vietnam has been generally overlooked during project implementation. Recently some large cities have adopted programs for household connections which include the construction of a tertiary piped network in the sidewalk, dedicated for connecting households. Effective use of the CSS will only come from a high rate of household connections to the CSS, which will in turn result in a higher concentration of organic loading in the combined sewage collected.

2.2.4. Effluent Standards

127. While effluent standards have been revised on four occasions between 1995 and 2011, this does not appear to have been driven by consideration of receiving water quality. Current effluent standards in Vietnam specify water quality parameters in terms of Class A and Class B depending on whether treated wastewater is discharged to water bodies with a function of drinking water supply (Class A) or not (Class B). Between 1995 and 2011, four versions of the effluent standards have been issued and, as shown in Figure 2.4, some variations have been made in the specified water quality parameters, notably for BOD, COD, ammonia and total nitrogen. The rationale for this evolution in standards is not entirely clear and does not appear to have been as a result of any analysis on the impact of wastewater effluent on surface water.

Figure 2.4 Evolution of Maximum Allowable Values in Vietnamese Effluent Standards, 1995 – 2011 period

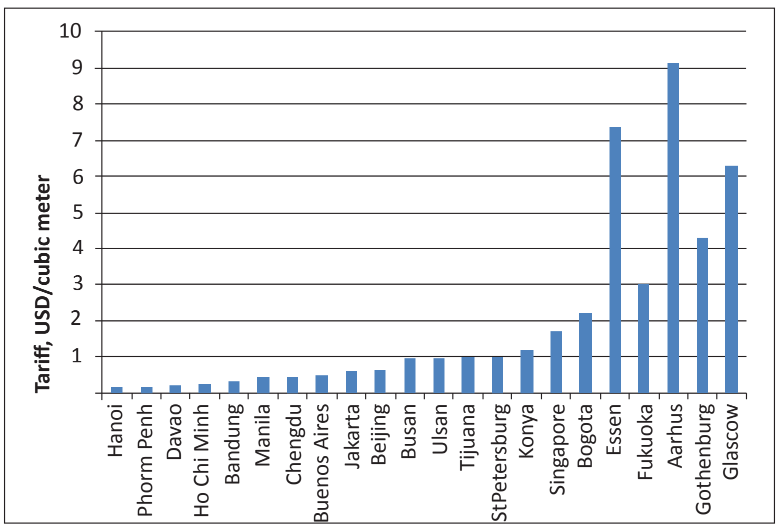


2.2.5. Cost Recovery

Performance Analysis

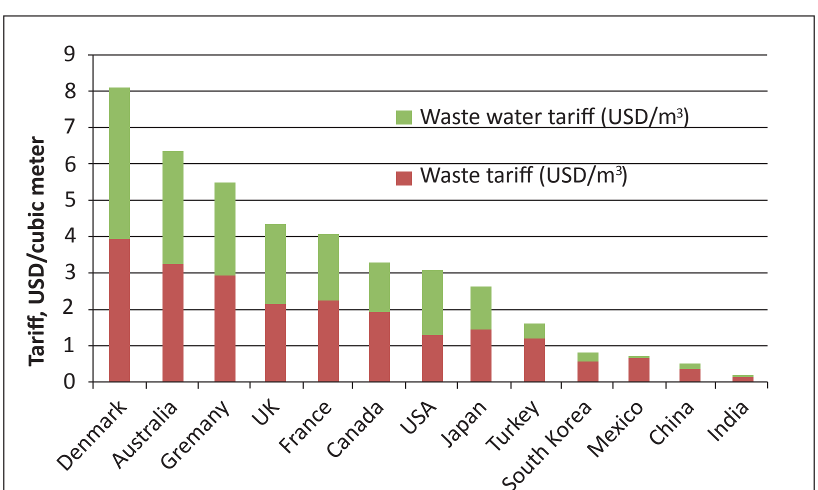
128. **Cost recovery, at least for operation and maintenance, is a core objective for a sustainable urban wastewater operation.** However, in Vietnam there are many constraints which currently do not allow full cost recovery. and 2.6compare water and wastewater pricing in a range of cities and countries. Clearly tariffs are much higher in developed countries which reflect both increased cost recovery, but also higher operating costs. As shown in Figure 2.6, water and wastewater tariffs in developed countries are similar, and this trend is expected to take place in Vietnam as well, suggesting that wastewater tariffs will increase in the future to meet costs.

Figure 2.5 Water and Wastewater Tariffs in Selected Cities in year 2012



Source: Global Water Intelligence and World Bank,2013

Figure 2.6 Comparison of Average Water and Wastewater Tariffs in Selected Countries



Source: Global Water Intelligence and World Bank, 2013

129. For urban sanitation projects in Vietnam where sufficient cost and revenue data is available, only 20-30 percent of actual O&M costs are being recovered in the form of collected fees[17]. The remaining costs are borne by local government based on annual budgets submitted by the operating companies. Local authorities appear to view these subsidies as a necessary government contribution to a public enterprise and therefore are reluctant to levy higher wastewater fees, even when the public awareness and satisfaction for the wastewater services provided is high. This was experienced in the field visit to Buon Ma Thuot City.

130. **However, cost recovery is also a factor of an appropriate system design as well as levying fees on the end users.** Despite this, many sanitation projects have been formulated based on available capital without taking sufficient account of the eventual operating costs over the project life cycle. These projects have been funded by long-term, low interest loans that will be paid back by central government and which often involve technically complex solutions resulting in high operating costs. Local authorities largely view this lending arrangement as a free investment, at least until such time that the investment has been completed. After completion, the constructed sanitation infrastructure must be operated over the life of the investment which hopefully will extend well past the payback period for the financing. What seems to be lost in the process is the realization that these long-term operating costs have a substantial impact on local budgets and in many cases have not been factored into future budgets until the project actually reaches completion.

131. There is an element of a lack of willingness to charge by local authorities which can hinder even the best prepared strategies for cost recovery. In the case of Buon Ma Thuot, it was found that future consumers were willing to pay for services up to a certain level. However, once the project became operational, local authorities abandoned the proposed fee structure proposed, and subsequently funded deficits in wastewater costs by means of local budget subsidy. Fortunately in the case of Buon Ma Thuot, the less technically complex wastewater treatment scheme has kept the O&M cost to a minimum but a subsidy of approximately 70 percent of total annual costs is still required.

Analyses and Discussions

132. The following highlights some of challenges faced with improving cost recovery related to the operation of urban wastewater systems in Vietnam:

- *Perception of benefit by end users.* If the end user is aware of benefits provided by a public wastewater system, such as improved environmental conditions in their neighborhood, improvement in local water bodies and a program for septage management, they will be more willing to pay fees to support the operation of the system. Conduct of information, education and communication campaigns serve to increase awareness of sanitation issues to the end users. Thus, customers who are better informed, with high awareness of the impact of good sanitation will have more willingness to pay based on perceived value of services offered.
- *Willingness to charge for wastewater services.* Local authorities who recognize the importance of cost recovery in terms of long-term financial sustainability are willing to take the political risk to increase fees to improve cost recovery, thus reducing the need for subsidy from local government. Strong government involvement in terms of levying an appropriate level of fees will drive improvements in cost recovery. Conversely many local authorities are unwilling to charge which stems from the long tradition of government subsidy of state-owned enterprises and provincial departments and this represents a significant barrier to cost recovery.

[17] For Lam Dong WSC (Da Lat city), cost recovery is 17.6% and for UMESC (Buon Ma Thuot city), cost recovery is 28.3%.

- Inappropriate choice of wastewater technology can lead to high operating costs which affects the ability of local government to recover these costs.

2.2.6 Septage Management

133. Septic tanks form the foundation of Vietnam's urban sanitation infrastructure. They are the primary mode of wastewater disposal for over 77 percent of households in cities and provincial towns, 40 percent in district towns, and 19 percent in rural areas. (WHO/UNICEF, 2008 and ADB, 2006). Most septic tanks in Vietnamese urban households receive only black wastewater. Grey wastewater from kitchen, bathroom and sink washing is generally discharged directly to the city's combined sewerage system, by-passing the septic tank. In urban areas, the septic tank plays an important pre-treatment role for locations having combined sewers. However, septage from most septic tanks is not emptied regularly. Illegal dumping of emptied sludge is a very common practice for all cities in Vietnam.

134. **The private sector has a greater role in septic tank de-sludging, collection and disposal or treatment** since public enterprises can collect only part of fecal sludge generated. However this business is not yet controlled by the city authorities. Households are not encouraged to empty the tanks regularly. Furthermore, since most of septic tanks are located under the basement, households often prefer not to break their floor and pay to empty their tanks unless the tanks are clogged and overflowing. In order to reduce operation costs and due to the lack of septage treatment facilities, most private fecal sludge collectors practice illegal dumping which contributes to pollution of the city environment with an adverse impact on public health.

135. **Some efforts in improvement of fecal sludge management are being made.** In Hai Phong city, scheduled de-sludging services undertaken by a public Hai Phong Sewerage and Drainage Company is free of charge with revenue from the wastewater fee (15 percent surcharge on the water bill) used to cover expenditure on scheduled FSM activities. Some cities taking part in the Vietnam–German Wastewater and Solid Waste Management Program (KfW and Swiss Secretariat for Economic Affairs [SECO] funds) intend to provide free septic tank emptying services to households covered by a gradual increase in the wastewater tariff.

136. **Emptying and delivery services, but not septage treatment expenditure, can be recovered by the application of competitive fees.** Critical factors in cost recovery are the selected technology for septage collection, treatment and reuse, and an accepted market price for the compost product. It should be possible for private companies to make profits from septage services and still dispose of septage in a controlled manner, but this will involve creating a better regulatory environment. Models for payment by customers for septage management include direct payment to the service provider upon de-sludging or indirectly through water bills as part of the wastewater service. The latter approach would involve scheduled septic tank de-sludging by either public or private enterprises, but controlled by the city authority. For services beyond scheduled emptying, additional payment would be made to the service provider.

2.2.7 Centralized versus Decentralized Systems

Performance

137. The concept of decentralized wastewater management systems for peri-urban and less densely populated areas is being recognized by sanitation planners. In addition to the conventional centralized wastewater collection and treatment approach that is being adopted for the more densely populated areas in the city, the decentralized wastewater management concept is appropriate for areas where centralized systems are not currently viable. Through an on-going study ''Unified Sanitation Sector Strategy and Action Plan - U3SAP,'' the Ministry of Construction has introduced decentralized low-cost sanitation options into the national context as a promising solution for low density communities in urban and rural areas.

138. **A number of decentralized wastewater systems have been installed across the country** for office buildings, hotels, factories, hospitals, new communities and trade villages. Technical guidelines for decentralized sanitation solutions are now being compiled by the Ministry of Construction and Ministry of Health. Decentralized, low-cost sanitation systems are being implemented in the small towns of Cho Ra and Cho Moi (Bac Kan province), Nuoc Hai (Cao Bang province), Minh Duc (Hai Phong city), An Bai (Thai Binh province) under a Water and Sanitation Program for Small Towns, supported by the Finish Government. Some demonstration projects have been initiated by local communities with external technical and financial support from donors such as community-based decentralized wastewater management systems in Lai Xa village, Kim Chung commune, Hoai Duc dictrict, Hanoi (YWAM NGO and MONRE, 2007),cluster wastewater treatment system in KieuKy hamlet, Gia Lam district, Hanoi (East Vietnam – ADB, 2012), Viem Xa village, Bac Ninh city, at schools in Vinh city and at a local market in Can Tho city (Wastewater and solid waste management program, GIZ, 2010 - 2013), etc.

Analyses and Discussions

139. **Decentralized sanitation systems can be more appropriate for those peri-urban parts of the city where communities are more isolated and population density is less.** The decentralized approach offers important benefits, such as the possibility of dealing with wastewater locally and applying pollution control measures close to the source. By tackling pollution problems close to their source, the large capital investment in trunk sewers associated with centralized systems can be reduced, thus increasing affordability.

140. **The decentralized systems are mostly developed and operated through a community-based approach,** where users are involved from the early stages of infrastructure system planning. Local resource contributions in decentralized wastewater management systems make the system's financial requirements more affordable and feasible and the user participation and the decision-making process more committed. In addition to the use of appropriate technologies, these are pre-conditions are for sustainability of the infrastructure. The success of decentralized systems would also depend on the availability of resources for sustainable operations. Decentralized systems have failed elsewhere in the world due to lack of sustained resources and technical capacity to operate the treatment facility.

141. **It is not a case of either centralized or decentralized.** There will be a place for both approaches in every city. It is at the citywide sanitation planning stage that areas where centralized and decentralized systems should be designated using basic criteria. Subsequently feasibility studies will be conducted to complete the economic and financial analyses required to establish the technology that will be implemented. The decentralized wastewater management approach is an appropriate choice for areas of a city than cannot be economically covered by a traditional centralized system. However, there is a need for continuing dissemination on the appropriate planning, design and operational requirements for decentralized systems including political advocacy, technical promotion and capacity building for all involved stakeholders

142. **There are common challenges for both centralized and decentralized wastewater projects.** These include technological option selection, quality of design and construction, administrative appraisal procedures, low rate of household connections, financial sustainability, local capacity for O&M, monitoring, evaluation and system control in the implementation stages. Key success factors for decentralized wastewater management systems relate to planning and decision-making, design of physical infrastructure and management arrangements for operations and maintenance. Participation of the community, awareness raising and local capacity building play significant roles in ensuring project success.

3. Recommendations and Conclusions

143. The wastewater sector in Vietnam is still relatively new compared with international practice and experience. Thus there are many opportunities for the sector to consider new approaches aimed at improving affordability and sustainability. Key principles to be considered in the decision making process at national and sector level and in planning steps are described in the following paragraphs.

3.1. Political Will and Institutional Reform

Place sanitation and hygiene promotion at the center of a prioritized program of action at central and local government levels

144. **The current commitment by central government to sanitation improvement needs to be sustained,** especially such that urban sanitation becomes elevated in terms of the national and local political agenda. This will require: increased efforts in building awareness to promote behavior change to encourage residents to connect to the sewerage system and pay for services; strengthening of public utilities in terms of cost recovery and service delivery; development of citywide sanitation strategies and adoption of technologies that rapidly increase wastewater and septage management coverage; and formulation of policies at both national and local government levels focused on hygiene promotion and improving sanitation sector performance.

Adopt a utility reform approach to sanitation service delivery

145. **Develop policies to address utility reform of the sanitation sector.** There is a need to create an enabling environment to encourage the establishment of corporate utilities or private sector organizations delivering an integrated service including water supply, sewerage, sanitation and septage management. This will require encouraging increased autonomy of the utility companies, adopting performance management approaches for O&M, addressing tariff reform to achieve cost recovery, introducing regulatory policies including an independent regulator and providing capacity building programs for service providers.

Improve coordination among central agencies

146. **There is a need for better co-ordination among central agencies in establishing the regulatory framework for wastewater and environmental management.** This will require frequent policy dialogue among key stakeholders at different levels, involving government officials, private sector operators, the community and donors. Without sufficiently addressing the regulatory framework and institutional capacity, investment efforts will fail to address urgent sector hot spots and fail to achieve sustainability. Greater coordination of sector agencies is required for programs to be efficient.

147. **The institutional arrangements in each City/Province are critical to effective project preparation, implementation and operation.** To improve effectiveness of service delivery, the current relationship between the wastewater service utility and the urban government -- which used to be based on an annual order approved by the local government -- should be replaced by, for example, a management contract for operation and maintenance of the wastewater system. A regulatory body with participation of provincial authorities and the public should be established that will approve unit prices and tariffs for wastewater services.

3.2. Integrated Approach, Investment Priorities and Project Planning

Establish a national strategy applying integrated water resources management principles

148. **Consider developing a national strategy that applies the principles of Integrated Water Resources Management and a River Basin approach to urban sanitation.** The Law of Environment 2005 and the Law of Water Resources 2012 could form the legal basis for this approach which would include the establishment of clear regulatory mechanisms for the sector, the consolidation of service providers and an emphasis on water quality management across river basins as well as improved sector performance at the central level.

149. **An integrated approach to implementation with components of water supply, sanitation and hygiene is likely to produce more sustainable results and more benefits.** There is a need to promote and develop coordination mechanisms between water resource management and environmental protection agencies, water supply and sanitation companies, and community organizations at all stages of project planning and implementation, within a river basin context.

Establish a National Target Program for urban sanitation that will include investment priorities

150. **A National Target Program for urban sanitation and identification of an investment framework would ensure results are sustained.** This would create a common basis for identifying priorities, increasing both technical and institutional capacities and developing financial mechanisms to raise and consolidate funds from various sources to meet these priorities. A national program would serve to coordinate and to mobilize the available resources and efforts of central government, local government, donors and non-state actors, including the private sector. An appropriate strategic or programmatic approach that would lead to a better targeting of investment to address the particular environmental and public health deficiencies, followed by proper investment planning is recommended.

Conduct strategic sanitation planning at basin and city levels

151. **Sanitation planning needs to adopt a strategic sanitation planning approach at the city and/or river basin level.** This approach would engage with the social, technical, institutional and economic factors that impact on the potential for sustainable service provision to all sectors of the urban community. Sanitation planning would benefit from being demand responsive to the needs of the users; considering incentives that improve performance of the stakeholders related to sound facility management, separate management of neighborhood facilities from downstream collection, treatment and disposal; and allow choices between a range of technical and financial management options depending on the particular situation. It is recommended that sanitation planning and service delivery consider the neighborhood or the community as the first level of demand expressions and develop appropriate infrastructure at that level.

Figure 3.1 Decentralized, Pre-fabricated WWTP for the Office Building

Photo by Nguyen V. A., 2012

152. **Technology selection and project design should take into account life-cycle costs.** Decision makers at all levels should be encouraged to participate in the

selection of those technologies and designs that not only successfully capture the financial and economic benefits of sanitation, but also at an affordable cost in each specific context. Household connections – sewerage and drainage – and wastewater treatment as well as wastewater and sludge reuse should be considered together.

3.3. Wastewater Systems: Centralized Versus Decentralized, Combined Versus Separate and the Role of Household Connections

Adopt centralized or decentralized wastewater systems depending on the local situation

153. **Centralized wastewater systems should not be considered the answer to all of Vietnam's sanitation problems.** Decentralized systems should be considered as an option for areas that cannot be economically serviced by a centralized network. Over time, these decentralized systems may become part of an expanded centralized network as population density increases. The citywide sanitation strategy developed at the master planning stage should identify a staged strategy for the development of both centralized and decentralized systems. Decisions on project phasing and selection of prioritized areas of investment should be based on comprehensive analysis, with least cost analysis and affordability being key to decision making.

Design approaches need to consider the impact of combined and/or separate systems

154. **During the sanitation planning process, the economics of separate (SSS) and combined (CSS) systems needs to be evaluated.** It may be more appropriate to continue to utilize and improve CSS systems for existing highly populated areas, while considering SSS systems for use in new development areas and in provincial cities/towns. Intermediate solutions or partially combined systems where alternative measures to divert runoff are implemented should also be considered. Proper rainfall seasonality analysis should be integrated in design of the system.

Figure 3.2 Connection of Household Sanitation Facilities to SSS

Source: BMT UMESC, 2009

155. Urban sanitation programs adopting combined systems should consider the critical issues of septic tank management, household connections and public awareness raising. Awareness raising is critical to preventing deposition of solid waste in the drainage system. In most cities in Vietnam, the drainage system that conveys combined sewage needs to be rehabilitated to provide appropriate slopes and protection against ingress of solid waste if it is to act as an effective combined sewer. Infiltration in the network can be controlled through innovative solutions such as reducing impermeable soils in the city, rain gardens, buffer strips, rainwater tanks, wet ponds and stream buffers.

156. For existing urban areas where upgrading of the CSS is expected to be implemented over an extended period, staged development of the WWTP is appropriate. Investment in the WWTP should be phased following the gradually expanding sewerage network and household connections. It may be appropriate

to design the facility on a modular basis where additional modules of each process stage are provided as wastewater flows increase. When warranted, especially for CSS which produces a dilute influent, the first stage may require cost effective treatment processes such as primary clarifiers or facultative ponds.

157. A comprehensive study on appropriate design of combined sewerage systems with receiving manholes and combined sewer overflow (CSO) chambers should be conducted. Construction of CSOs and their operation and maintenance are key issues to be considered especially for coastal cities affected by tidal regimes. Vietnamese design standards for WWTP loading rate calculations currently do not distinguish between CSS and SSS collection methods despite the significant differences in wastewater characteristics. This needs to be carefully considered in wastewater project planning and technology selection. Priority in sanitation planning should be on the management of the network, rather than just on end-of-pipe solutions.

Household connections are an integral part of wastewater system development

158. **House connections are vital to the successful implementation of any wastewater system project** and their full integration within the planning and funding of the program should be considered. Improvement to both the quantity and quality of house connections to piped sewerage systems, whether CSS- or SSS-based, would allow the most effective use of public wastewater infrastructure.

159. It is critical that programs to increase the quality and coverage of household connections to public sewerage systems are accelerated given the pivotal role this element plays in the success of any urban wastewater system regardless of collection type. The following methodology could be effective in scaling up the rate of household connections:

- Increase public awareness by launching an IEC campaign to promote the connection of households to the public sewer system, citing the benefits of the program to the homeowner and the environmental improvement to the community as a whole.
- Local authorities issue enforceable regulations mandating that all households, commercial establishments and institutions within a constructed sewerage collection network service area be connected to the system.
- Provide a government subsidy for households carrying out household connections, so as to encourage connections and to reduce the financial burden on the disadvantaged HHs, especially the poor.
- Local authorities establish a specific house connection group or department within the company responsible for operating the sewerage system. The expressed purpose of this group is to promote, issue permits and monitor household connections throughout the sewerage service area.

3.4. Wastewater Treatment Technology and Effluent Standards

Select appropriate wastewater treatment technologies

160. To effectively scale up the sanitation sector in Vietnam, greater emphasis needs to be placed on the selection of treatment technology. The technology selected needs to suit the influent wastewater characteristics, the performance requirements based on effluent standards, the specific site conditions and the receiving waters. Decision makers at all levels should be encouraged to participate in the selection of those technologies and designs that not only successfully capture the financial and economic benefits of sanitation, but also at an affordable cost considering life cycle costs and acceptable wastewater tariffs.

Allow some flexibility in effluent discharge quality based on receiving waters

161. **The assimilation capacity of receiving waters as well as the influent quality should be considered in the design of treatment facilities.** Current effluent standards require that wastewater be treated to high levels to achieve low concentrations of ammonia and total nitrogen which effectively precludes the use of simpler technologies, such as wastewater stabilization ponds or trickling filters. The outcome is unaffordable operation and maintenance costs. Some affordable wastewater collection and treatment options potentially applicable for decentralized wastewater treatment systems are simplified sewerage, baffled septic tanks with anaerobic filters and constructed wetlands and public sanitation facilities with biogas recovery. However, these treatment systems may not comply with the current effluent standards. A potential approach is to start out with lesser (or no) limits for nutrients (for non-sensitive receiving waters), but then increase over a period of time, during which the sanitation sector has had time to develop and financial resources have been mobilized.

Figure 3.3 Discharge of CSS Overflow to Da Nang Beach

Photo by Corning J, 2012

162. **A staged approach to the development of WWTPs should be considered.** Given the current diluted effluent, a phased approach on the development of the wastewater collection and treatment should be considered. For example, a staged approach could allow cities to invest in physical/chemical treatment units initially, allowing additional expenditure on network development and house connections, while biological treatment processes are added later. An integrated water resource management and river basin approach to establishing effluent standards could also significantly reduce wastewater treatment costs while innovative solutions could be considered such as:

- application of chemical enhanced primary treatment processes (CEPT);
- marine outfalls for CETP treated wastewater in less sensitive coastal and island areas;
- reuse of treated effluent treated wastewater for irrigation; and
- use of stabilized bio-solids for fertilizer.

3.5. Financing Mechanisms for Wastewater System and Cost Recovery

Financing Mechanisms for Wastewater System and Cost Recovery

163. **Financial sources other than ODA will need to be mobilized to meet the sector investment need.** This will require co-ordination of government-donor dialogue on sector financing at high level, and among government agencies at central and local levels. The development of a National Strategy and a National Target Program for Sanitation will assist with effective mobilization of funds including ODA, Government budget and the private sector. Financing needs are still very high, estimated to be USD 8.3 billion to provide sewerage to the estimated 36 million urban population by 2025.[18] While sanitation investment to date[19], has largely been ODA sourced, with country economic growth it is anticipated that ODA sources will be significantly reduced, replaced by commercial credit modes. This national level coordinated strategy and program should also enhance more efficient use of other potential financial resources such as expenditure from the environmental protection state budget.

164. **Develop appropriate financing policies and mechanisms for the sanitation sector for both investment and O&M.** This may include grant finance, government bonds, appropriate tariff measures, PPP arrangements and other innovative sources of finance such as the introduction of property taxes or earmarked increases of personal income taxes.

Prepare a roadmap to increase revenue and increase cost recovery

- Increase wastewater fees incrementally over time in accordance with willingness to pay surveys, so as to permit a gradually improved cost recovery.
- Increase consumer awareness of the importance of improved sanitation through continuing IEC programs. This will facilitate consumer perception of the value and benefit of the sanitation services provided.
- Cost-recovery strategies should include clear criteria to reduce costs so as to avoid passing on inefficiencies to consumers through tariffs. Local utilities should recover costs and secure adequate cash-flows to guarantee O&M but such mechanisms should incorporate instruments to guarantee that costs are adequate.

Figure 3.4 Activated sludge WWTP

Source: Corning J., 2012

- Local authorities and water companies need to be willing to charge customers a tariff that will achieve cost recovery.
- Financial support for poor households' sanitation needs can be provided through tariff cross subsidies or through micro-financing programs such as micro-credits and revolving funds.

[18] Estimated with average capita cost of USD 250 for investment in urban wastewater system. An average of 3% per annum annual population growth was assumed in establishing the estimated 2025 urban population of 36 million.

[19] Estimated to total USD 2.1 billion over the past decades.

166. It is critical that the local authorities commit to providing financial support for the balance of costs not covered by the collected fees, including both for routine and preventative maintenance. A commitment to OPEX by local authorities can be a strong driver of improvement to the urban sanitation services offered. If the budget is only for routine or reactive services, then long-term maintenance can be at risk, potentially resulting in early failure and poor service quality of sanitation systems.

167. **Government will need to provide investment subsidies for treatment plants in priority towns.** Low income consumers in small towns cannot currently pay tariffs required to achieve full cost recovery for wastewater treatment. In order to increase the coverage of treated wastewater, government subsidy at least for CAPEX is required. These subsidies can be well justified both from the stand point of environmental protection and poverty alleviation and such grant financing from the central government has been provided in other countries for sanitation investments.

Develop policies to attract the private sector for investment in wastewater collection and treatment

168. Policies encouraging private sector participation in the sanitation sector include actions to improve the business working environment such as access to loan sand increase in wastewater fees to provide for O&M cost recovery. Integration of water and wastewater services will make the sector more viable. Private sector investors in land development can include wastewater collection and treatment capital expenditure into costs of land or housing which will be later sold to the customers at market prices, thereby reducing Government expenditure. However, infrastructure developed by the private sector needs to be aligned with the city's Master Plan. Private sector investments in sanitation need to be coordinated with those from Government to ensure poor communities are targeted in addition to potentially more profitable areas. There are several potential PSP modalities; however, it is critical that investments from the private sector in combination with government result in a complete wastewater system incorporating connections, and network and treatment facilities.

3.6. Capacity Development of Stakeholders and Creation of Community Awareness of Sanitation Benefits

Build capacity among service providers and owners of sanitation services to improve system efficiency and sustainability

169. **Capacity building is required at all levels throughout the urban sanitation sector,** from the central government level down to the decision-makers at the local authority level. This would include activities to build capacity among service providers and owners of sanitation services. Increased capacity, coupled with improved coordination, will create improved performance efficiency in project implementation.

170. It is recommended that engineered facilities be designed together with ''soft interventions'' such as capacity building, institutional and financial arrangements. Local authorities should consider ensuring that all stakeholders, from the decision makers to those employed in public utilities and service providers, have a greater awareness of the broad range of engineering, environmental, managerial, institutional and social knowledge and skills that are necessary for successful project development and service provision.

Increase awareness of the community of the benefits of wastewater services

171. Information, Education and Communication programs to promote behavior change should be implemented to increase public awareness and appreciation of the benefits of environmental sanitation.

Whereas it is important for the local authorities to have the necessary "tools" for charging customers for sanitation services, it is equally important that the customers themselves be aware of the benefits and be willing to pay for those services. It is recommended that an IEC campaign be included in the development of every wastewater project to increase awareness of sanitation issues in general, but more specifically to inform people of the benefits provided by the system. This will encourage customer support for connecting their household sanitary piping to the public sewerage system, increase their willingness to pay, and result in an increased level of fees collected with consequent improvement to cost recovery.

3.7. Septage Management in Urban Areas is a Critical Aspect of Sanitation Planning

Develop a septage management strategy at the city level

172. **Local authorities need to develop a septage management strategy at the city level.** Septic tanks will continue to play an important pre-treatment role for existing urban locations having combined sewer systems in Vietnam. Local governments should issue regulations related to septic tanks in combination with requirements of household connection and management of urban wastewater systems. The following actions related to septage management should be taken by local authorities:

- develop a septage management strategy which should be incorporated into urban infrastructure planning;
- raise awareness and provide technical and financial support through appropriate programs such as micro-financing or a revolving fund;
- enforce regular de-sludging of septic tanks;
- consider financial support to FSM businesses, such as payment for septage properly delivered to the treatment plant and access to favorable financing for investment in the FSM business;
- establish a revenue structure for FSM management either through wastewater fees or an environmental charge;
- apply strict control on septage collection, disposal, treatment and reuse ; and
- provide effective awareness raising for the public and FSM enterprises.

173. Citywide sanitation strategies undertaken at the local authority level should determine areas of the city where septic tanks are part of the sanitation solution. Development of an improved design for septic tanks is also a crucial need. In areas where septic tanks are found to be needed, subsidies for construction or rehabilitation of septic tanks should be considered. Where SSS is foreseen, the disconnection of septic tanks can be part of the development stage of the urban wastewater system.

174. For combined sewerage systems, the issue of household connections is integral with the performance of the septic tank as the system relies on removal of solids prior to discharge to the drainage network. There should be adequate design, construction and management of the septic tank including regular removal of the septic tank sludge. These requirements should be clearly stated in central and local regulations on urban wastewater management. The average investment cost for construction of a septic tank and the household connection and the fee for septic tank emptying should be included in financial analysis during the selection of the most appropriate urban wastewater collection and treatment system.

175. Recommended actions addressed to central and local government, aiming at improvement of urban wastewater management efficiency and sector sustainable development, are given in Table 3.1.

Table 3.1 Recommended Actions to Improve of Urban Sanitation Management and Sustainable Development

Recommen-dations	Practical Measures to be Taken	National level	Local level
Comprehensive and strategic technical decisions needed at the planning stage	National government to mandate local government to adopt a strategic sanitation approach that will engage with the social, technical, institutional and economic factors to develop appropriate sanitation service provision to all sectors of the urban community.	X	X
	During the sanitation planning process, evaluate the economics of separate (SSS) and combined (CSS) systems. Intermediate solutions or partially combined systems where alternative measures to divert runoff are implemented should also be considered.		X
	Local governments to undertake sanitation planning on a citywide or basin wide basis using cost effectiveness and inclusiveness criteria at the city level, where on-site and decentralized systems for lower density peri-urban areas are considered together with centralized systems for high density urban areas, giving consideration to the needs of low income communities.		X
	Ensure household connections are an integral part of wastewater system development and accelerate programs to increase the quality and coverage of household connections to the public sewerage systems.		X
Increase the efficiency of treatment processes	Provide WWTP technology that, while compliant with effluent standards, is also appropriate within the context of land availability, weak influent conditions, limited investment costs and optimal cost for operation and maintenance considering life-cycle costs.		X
	The assimilation capacity of receiving waters as well as the influent quality should be considered in the design of treatment facilities.		X
	Given the current dilute influent, consider a staged approach to wastewater treatment whereby cities initially invest in physical/chemical treatment units, allowing additional expenditure on network development/house connections, while biological treatment processes are added later when influent quality dictates.		X
Address and prioritize septage management.	Local government to develop a Septage Management Strategy and incorporate into urban infrastructure planning.		X
	Local government to pass and enforce ordinances to cover proper design and construction of septic tanks, regular de-sludging of septic tanks and appropriate disposal of septage by service providers.		X
	The task for septage management services to be assigned to a local public utility or private sector operator and paid for directly by the users, through water bills or as part of the wastewater fee.		X
	Awareness raising campaigns to be directed at local government and the public to ensure that the importance of proper septage management is understood.		X

Recommen-dations	Practical Measures to be Taken	National level	Local level
Develop a national program for urban sanitation and improve legal framework	The current commitment by central government to sanitation improvement needs to be sustained through awareness building activities, strengthening of public utilities, development of citywide sanitation strategies, development of technologies to scale-up wastewater coverage and formulation of policies focused on hygiene and improving sanitation performance.	X	X
	Develop a National Strategy and National Target Program for urban sanitation that applies the principles of Integrated Water Resources Management and a River Basin approach and identifies an investment framework that will coordinate sector financing among government agencies at central and local levels.	X	
	Develop appropriate financing policies and mechanisms for the sanitation sector including the use of grants, government bonds, tariff measures, PPP arrangements and other innovative financing models.	X	
	Local authorities must be prepared to charge tariffs that will achieve operational cost recovery and financial sustainability giving consideration to affordability and willingness to pay.		X
	Introduce enforceable regulations (in parallel with effective IEC activities and financial assistance programs) which mandate that all households, commercial establishments and institutions within a constructed sewerage collection network service area be connected to the system, with appropriate cross-subsidies of financial support for low income communities.	X	X
	Promote better co-ordination among central agencies in setting up of regulatory framework for river basin based wastewater and environmental management;	X	
	Conduct frequent policy dialogue among key stakeholders at different levels, involving government officers, private sector, operators, public, donors, etc.	X	X
Create enabling conditions for adequate service delivery at the local level	National government to encourage reform of sanitation utilities through developing policies creating an enabling environment for the establishment of autonomous utilities delivering an integrated service including water supply, sewerage and septage management.	X	X
	Create utilities that focus on service delivery rather than infrastructure management, leaving the regulatory function for the local government.		X
	Encourage private sector participation through development of appropriate regulations for private sector involvement and cost recovery through suitable tariffs.	X	
	Government to encourage local authorities/utilities to integrate physical infrastructure development with improving ongoing service delivery with improvements in public awareness, hygiene promotion and coordination with community organizations at the utility management and regulatory level.	X	X

Recommen-dations	Practical Measures to be Taken	National level	Local level
	To improve the effectiveness of service delivery, the current relationship between the wastewater service utility and the urban government should consider a management contract for operation and maintenance of the wastewater system.		
	Government to address lack of public awareness on sanitation through conduct of IEC campaigns on technical, health, environmental, economic and financial impacts of improved sanitation.		
	For improved sanitation implementation, special attention needs to be taken to build capacity among service providers and owners of sanitation services to improve program efficiency and sustainability.		

APPENDICES

APPENDIX A - KEY PERFOMANCE INDICATORS OF VIETNAM SANITATION SECTOR

Population and Growth Rates	Year		
	2000	2005	2010
Population (million) (GSO, 2010)	77.6	82.2	86.8
Population, total annual growth rate (%) (GSO, 2010)	1.2		
Urban share (GSO, 2010)	18.7	22.5	26.3
Urban annual growth rate (%) (GSO, 2010)	3.5		
Rural share (GSO, 2010)	58.9	59.7	60.5
Rural annual growth rate (%) (GSO, 2010)	0.3		

MDG Targets	Value	Note
MDG water supply target coverage (%) by 2015 (WHO – UNICEF, 2010)	79	Baseline 1990: 58%
MDG sanitation target coverage (%) by 2015 (WHO – UNICEF, 2010)	68	Baseline 1990: 36%
Infant mortality (per 1000 live birth) by 2015 (WHO – UNICEF, 2010)	15	Baseline 1990: 44.4%. 2009: 16

Current Sector Performance	Value	Note
Urban sanitation coverage access to toilet (%)	91; 94	94%: JMP, WHO – UNICEF, 2008; 91%: WB - Hydroconceil & PEM, 2008
Urban sewerage connections (%)[1]	60	Nguyen V. A. et al, 2012
WWT volume treated by 2012 (MLD)	438	See Appendix C
Installed capacity of WWT by 2012 (MLD)	530	See Appendix C
Urban wastewater treated (%)	10	Based on volume of wastewater treated vs. volume of urban water supplied (MOC - WB, 2013))
Proportion of systems that are combined waste water and drainage systems (%)	92	See Table 1.1, Main Report
Proportion of systems that are separate wastewater and drainage systems (%)	8	Center part of Buon Ma Thuot and Da Lat, new areas in other cities
Urban access to on-site sanitation (%) (Nguyen V. A. et al, 2012)	40	Not including connections to drainage and sewerage network
Urban proportion of septage treated (%)	4.3	Estimated by Study team
Rural water supply coverage, JMP access (%) (WHO – UNICEF, 2010)	92	Only 42% meet MOH hygienic water standard (MARD – MOG, 2011)
Rural sanitation coverage, JMP access (%) (WHO – UNICEF, 2010)	66	Only 18% meet MOH hygienic toilet standard (UNICEF – MOH, 2007)

Current Sector Performance	Value	Note
Water resources, per capita per year (m^3/p/year)[20] (Nguyen V. A. et al, 2011)	3,840	2,830 by 2025
Urban water supply coverage, JMP access (%)(WHO – UNICEF, 2010)	99	73% in 2011 (JICA, 2011); 80% in 2012 (Nguyen V. A. et al, 2012)
Share of urban population with 24/7 water supply (%) (VWSA, 2006)	60	
Share of urban water supply samples meeting water quality standards (%) (JICA, 2011)	59	

Note: *[1] Percentage of urban population connected to combined or separate sewerage network, with/without wastewater treatment. This number includes households with on-site sanitation facilities. In Vietnamese cities most septic tanks treat black wastewater where the effluent is discharged to combined drainage mixed with untreated grey wastewater and storm water.*

Financial Performance	Value	Note
Per capita GDP, 2011 (USD) (WB, 2011)	1,408	401.5 in 2000
Total annual water investments (USD million) (Nguyen V. A. et al, 2012)	88.4	USD 1,238 million over period 1991 – 2005.
Total annual investment in environmental protection (USD million) (Grontmij – WSP, 2012)	400	ODA: USD 2,100 million over period 1995 – 2009 or USD 150 million per year[2]. Government budget for Environmental protection: USD 250 million per year
Sanitation sector investments as percentage of GDP (%) (adapted from Grontmij – WSP, 2012)	0.45	Including 0.2% from ODA and 0.25% from Gov. EP budget
Representative WSS Tariffs (VND per m^3)	4,000	See Table 1.5
Representative WWT Tariffs (VND per m^3)	400	See Table 1.5
Desludging fee (VND) (Nguyen V. A. et al, 2012)	700,000	
Non-Revenue Water (%) (JICA, 2011)	30	In 2000: 40%
Typical CAPEX costs/capita of septage management (USD 2010 prices) (adapted from Nguyen V. A. et al, 2012)	0.2	Calculated for Hai Phong city case

Note: *[2] Investment over the past 5-10 years has increased significantly to approximately USD 250 million/year.*

[20] Cubic meters (m^3) per person per year.

APPENDIX B - LIST OF WASTEWATER TREATMENT PLANTS (WWTPs)

Table B1: In-operation WWTPs (as of the end of September, 2013)

No	Plant	City	Year startup	Capacity (m^3/d)		Sewer type	Treatment process/technology
				Designing	Funct.		
1	Kim Lien	Hanoi	2005	3,700	3,700	CSS	A2O (AS)
2	Truc Bach		2005	2,500	2,500	CSS	A2O (AS)
3	Bac Thang Long		2009	42,000	7,000	CSS	AO with nitrification
4	Yen So		2012	200,000	120,000	CSS	SBR
5	Binh Hung	HCM City	2009	141,000	141,000	CSS	CAS
6	Binh Hung Hoa		2008	30,000	30,000	CSS	Aer. Ponds + Mat. Ponds
7	Canh Doi (Phu My Hung)		2007	10,000	10,000	SSS	OD
8	Nam Vien (Phu My Hung)		2009	15,000	15,000	SSS	A2O (AS)
9	Son Tra	Da Nang	2006	15,900	15,900	CSS	Ana. Pond w/float cover
10	Hoa Cuong		2006	36,418	36,418	CSS	Ana. Pond w/float cover
11	Phu Loc		2006	36,430	36, 430	CSS	Ana. Pond w/float cover
12	Ngu Hanh Son		2006	11,629	11,629	CSS	Ana. Pond w/float cover
13	Bai Chay	Quang Ninh	2007	3,500	3,500	CSS	SBR
14	Ha Khanh		2009	7,000	7,500	CSS	SBR
15	Da Lat	Da Lat	2006	7,400	6,000	SSS	Imhoff tank + Trick. Filt.
16	Buon Ma Thuot	B. Ma Thuot	2006	8,125	5,700	SSS	Stab. Ponds (AP,FP,MP)
17	Bac Giang	Bac Giang	2010	10,000	8,000	CSS	OD

Table B2: In-progress Wastewater Treatment Plants

No	Plant	City/ province	Capacity (m^3/d)	Sewer	Technology	Status
1	Westlake (Tay Ho Tay)	Hanoi	22,800	CSS	SBR	Under construction
2	Yen Xa		275,000	CSS	CAS	Under design
3	Bay Mau		13,300	CSS	CAS	Under design
4	Phu Do		85,000	CSS	SBR	Design completed
5	Tham Luong- Ben Cat	HCMC	250,000	CSS	SBR	Under construction
6	Nhieu Loc -Thi Nghe		480,000	CSS	SBR/CAS	Under design
7	Thai Nguyen	Thai Nguyen	10,000	CSS	OD	Under construction
8	Vinh Niem	Hai Phong	36,000	CSS	CAS	On-going bidding
9	Hai Duong	Hai Duong	13,500	CSS	SBR	Under construction/connection
10	Quat Luu	Vinh Phuc	5,000	CSS	CAS	Under construction
11	Tu Son	Bac Ninh	20,000	CSS	SBR	Under construction/connection
12	Phu Ly		5,000	CSS	CAS	Under construction/connection
13	Bac Ninh	Bac Ninh	17,500	CSS	SBR	Construction completed. Under commissioning
14	Vinh	Nghe An	25,000	CSS	SBR	Construction completed. Under commissioning
15	Nam Thu Dau Mot	Binh Duong	17,650	SSS	SBR	Construction completed. Under commissioning
16	Thanh Hoa		15000	CSS	WSP + CW	Under design
17	Cua Lo	Nghe An	7,500	CSS	SBR	Under construction/connection
18	Duc Minh	Quang Binh	8,570	CSS	Aerated lagoon	Under construction
19	Ha Thanh (1C)	Binh Dinh	14,000	CSS	CEPT + TF	Under construction
20	NM XLNT số 2		8,000	CSS	OD	On-going bidding

No	Plant	City/ province	Capacity (m^3/d)	Sewer	Technology	Status
21	Hue WWTP No. 2	Hue	17,100	CSS	CAS	Under construction
22	Hoa Xuan		20,000	CSS	OD	Under construction
23	Lien Chieu	Da Nang	40,000	CSS	OD	Under design
24	Hoi An	Quang Nam	7,000	SSS	CAS	Under construction
25	Nha Trang	Nha Trang	40,000	CSS	OD	Under construction
26	Cai Sau	Can Tho	32,000	CSS	OD	Under construction
27	Soc Trang	Soc Trang	17,570	CSS	Prim. Sed.	Phase 1 completed and operated in June 2013
28	Ba Ria	BR-VT	12,000	CSS	OD	Under construction
29	Vung Tau		20,000	CSS	OD	Under construction
30	Tra Vinh	Tra Vinh	18,135	CSS	Prim. Sed.	Under construction
31	Chau Doc	An Giang	2,000	SSS	A2O lagoon	Lack of HHs connections
32	Phan Rang – Thap Cham	Ninh Thuan	10,000	CSS/SSS + reuse	Aerated lagoon	Under construction

Table B3: Summary Operation Status

Location	Type of Facility/Treatment Process	Summary Status
Hanoi	Four WWTPs with total capacity of 248,000m^3/d: im Lien (3,700m^3/d)/A2O with chlorination; - Truc Bach (2,300m^3/d)/A2O with chlorination; - Bac Thang Long (42,000m^3/d)/AS with nitrification and chlorination; - Yen So (200,000m^3/d)/SBR with nitrogen removal and UV disinfection.	CSS; HH connection: ~80-90% HH with septic tank: ~80-90% Treatment problems: less BOD content in influent so experiencing challenges with nitrogen removal. Insufficient influent flow (17% of rated capacity) received at Bac Thang Long WWTP. Wastewater tariff: Environmental protection (EP) fee (10% of water supply [WS] cost), equiv. 0.34USD/20m^3. Only for Bac Thang Long IP: 400VND/m^3
HCMC	Two WWTPs with total capacity of 171,000m^3/d: - Binh Hung (141,000m^3/d)/CAS - Binh Hung Hoa (30,000m^3/d)/Aerated Ponds+Mat. Ponds	CSS; HH connection: 90%; Treatment problems: odors generated from sludge composting operation (Binh Hung plant) Wastewater tariff: : EP fee (10% of WS cost)
Bac Giang	Bac Giang WWTP (10,000m^3/d): Oxidation ditch AS with chlorination.	CSS and SSS; HH connection: 90%; Treatment and operational problems: not being operated optimally. No sludge wasting since startup 1.5 years ago. Wastewater tariff: EP fee (10% of WS cost) but revenue not being returned to wastewater O&M.
Quang Ninh	Two WWTPs with total capacity of 11,000m^3/d: - Ha Khanh (7,500m^3/d/SBR - Bai Chay (3,500m^3/d)/SBR	CSS Treatment and operational problems: low BOD content in influent. Wastewater tariff: EP fee (10% of WS cost)
Da Nang	Four WWTPs, all having the same treatment technology (Covered Anaerobic ponds) with total capacity of 64,400m^3/d. - Hoa Cuong (36,418m^3/d); - Son Tra (15,900m^3/d); - Phu Loc (36,430m^3); and - Ngu Hanh Son (11,629m^3/d).	CSS. HH connection: 10%; Treatment and operational problems: desludging of ponds is required. Lack of disinfection process. Wastewater tariff: EP fee (21% of WS cost) by 2012

Location	Type of Facility/Treatment Process	Summary Status
Buon Ma Thuot	Buon Ma Thuot WWTP (8,125m^3/d): Three stage stabilization ponds (AP-FP-MP). Reuse of treated effluent by irrigation of coffee fields.	SSS (Without septic tanks). HH connection: 4700 (85% of designed); HH with septic tank: 90% (in non-SSS area) Treatment and operational problems: non-achievement of NH_4-N, Coliform effluent standards. De-sludging of first AP required soon. Wastewater tariff: 200VND/m^3 (EP fee)
Lam Dong	Da Lat WWTP (7,400m^3/d)/Imhoff tank and Trickling filter. Reuse of waste sludge through sale of 100% of composted dried sludge.	SSS; HH connection: 75%; HH with septic tank: 90% Treatment and operational problems: NH_4-N, DO Wastewater tariff: 1000VND/m^3-water used for connected HHs (Dec. 88), 300VND/m^3 of water used as EP fee (Dec. 67) for not-connected HH

APPENDIX C - CASE STUDIES

CASE STUDY 1: WASTEWATER QUALITY, WASTEWATER EFFLUENT STANDARDS AND TECHNOLOGY SELECTION

1. Introduction and Scope

This case study will examine the application of wastewater treatment technologies in Vietnam, focusing on the 17 wastewater systems currently in operation. An overview of these 17 wastewater systems is presented based on information obtained through interviews conducted during site visits to each facility and the results from a survey (via questionnaire) conducted on behalf of the Review by the Vietnam Water and Sewerage Association. Following the technology overview, the impact of weak influent conditions due to the prevalent use of combined sewerage collection systems is evaluated.

A perspective on where the sanitation sector is heading based on those projects now underway, either in the design or construction stages, is presented. Finally, recommendations are made considering the use of appropriate treatment technologies in the context of site availability, sewage collection type, available resources for operation and maintenance (O&M) and attainment of relevant effluent standards.

2. An Overview of Wastewater Treatment Technologies in Vietnam

By the end of September, 2013, a total of 17 wastewater treatment systems have been operated in urban areas in Vietnam. The first of these WWTPs commenced operation in 2005, demonstrating the recent development of the sanitation sector in Vietnam. Details of these facilities are outlined in Table C1.

It is noted that 12 of the 17 wastewater treatment system operate in the principal cities of Hanoi, Ho Chi Minh City and Da Nang, with the remaining five systems operating in Provincial cities and towns. The WWTPs range in design capacity from 3,500m^3/day (Bai Chay) to 200,000m^3/day (Yen So, Hanoi).

Thirteen of the 17 current wastewater treatment systems receive sewage by means of a combined sewerage system (CSS), with only four systems (Da Lat, Buon Ma Thuot and Canh Doi and Nam Vien, both in Phu My Hung), collecting the sewage by means of separate sewerage systems, which specifically exclude the entry of rainwater or drainage. The impact of these two different collection methods is discussed in subsequent sections of this case study.

To date, wastewater treatment technology has been focused on the use of some form of activated sludge secondary treatment technology, such as conventional activated sludge (CAS), anaerobic-anoxic-aerobic (A2O), oxidation ditch (OD) and sequencing batch reactor (SBR) technologies. The use of activated sludge treatment technologies was promoted in the JICA-funded projects of Kim Lien, Truc Bach, Bac Thang Long, all in Hanoi, and for the Binh Hung WWTP in Ho Chi Minh City, which followed the well-established trend in Japan for application of this type of wastewater treatment technology.

The 17 treatment facilities listed in Table C1 fall into the three main categories of Activated Sludge Process (Conventional Activated Sludge, Anaerobic-Anoxic-Oxic, Sequencing Batch Reactor, and Oxidation Ditch); Fixed Film Process (Trickling Filter) and Pond System.

Table C1: Operational WWTPs Surveyed During the Study

STT	Plant	City	Year start up	Capacity (m^3/day)		Sewer type	Treatment process/ Technology
				Designed	Function		
1	Kim Lien	Hanoi City	2005	3,700	3,700	CSS	A20 (AS)
2	Truc Bach		2005	2,500	2,500	CSS	A20 (AS)
3	Bac Thang Long		2009	42,000	7,000	CSS	A20 with nitrification
4	Yen So		2012	200,000	120,000	CSS	SBR
5	Binh Hung	HCM City	2009	141,000	141,000	CSS	CAS
6	Binh Hung Hoa		2008	30,000	30,000	CSS	Aer. Ponds +Mat. Ponds
7	Canh Doi (Phu My Hung)		2007	10,000	10,000	SSS	OD
8	Nam Vien (Phu My Hung)		2009	15,000	15,000	SSS	A20 (AS)
9	Son Tra	Da Nang	2006	15,900	15,900	CSS	Ana. Pond W/float cover
10	Hoa Cuong		2006	36,418	36,418	CSS	Ana. Pond W/float cover
11	Phu Loc		2006	36,430	36,430	CSS	Ana. Pond W/float cover
12	Ngu Hanh Son		2006	11,629	11,629	CSS	Ana. Pond W/float cover
13	Bai Chay	Quang Ninh	2007	3,500	3,500	CSS	SBR
14	Ha Khanh		2009	7,000	7,500	CSS	SBR
15	Da Lat	Da Lat	2006	7,400	6,000	SSS	Imhoff tank + Trick. Filt.
16	Buon Ma Thuat	BMT	2006	8,125	5,700	SSS	Stab. Ponds (AP, FP, MP)
17	Bac Giang	Bac Giang	2010	10,000	8,000	CSS	OD

Ten of the 17 WWTPs in urban areas of Vietnam currently utilize some form of activated sludge treatment technology. The remaining seven WWTPs utilize simpler forms of treatment technologies including four covered anaerobic pond systems (Da Nang), a stabilization pond system (Buon Ma Thuot), an aerated lagoon/maturation pond system (Binh Hung Hoa-HCMC) and a imhoff tank/trickling filter system (Da Lat). Generally, these simpler technology choices require less electrical power, chemicals, trained personnel and replacement components with which to operate as compared with the activated sludge treatment systems.

The technology adopted for the 17 wastewater treatment systems vary widely from covered anaerobic pond WWTPs (in Da Nang) to more advanced activated sludge systems, as found at Binh Hung WWTP (HCMC) and at Yen So (Hanoi). However, this variation is due not so much to influent/effluent parameters as it is to site-specific factors such as land availability and available resources for O&M.

Unrealistic Influent Wastewater Characteristics Create Overdesign of WWTPs. The technology selected for the current 17 WWTPs was not always chosen based on influent conditions or effluent standards, as would normally occur. This technology selection can best be illustrated by the WWTPs at Yen So (Hanoi) and Binh Hung (HCMC). Much more concentrated influent organic loading conditions were assumed during the design phase for these two large WWTPs than were ultimately encountered upon start up. For example, at Yen So WWTP, a design influent BOD of 200mg/l was assumed, although an average influent BOD concentration of less than 50mg/l is actually received at the WWTP. A similar disparity between design- and actual influent conditions also exists for the Binh Hung WWTP. This disparity, between assumed and actual influent organic loading, results in an overcapacity of the biological treatment processes, especially related to aeration of the wastewater. While this excess capacity allows for future improvements in the sewerage network that would provide more concentrated influent flows, it is not clear whether local authorities in Hanoi and HCMC are willing and financially capable of making the significant investment in sewerage infrastructure required to match the capacity of the treatment facilities.

Influence of lending institutions in support of specific treatment technology. Certain international donors tend to favor specific treatment technologies which are prevalent in their country of origin. Whereas some of these WWTPs had very specific site constraints justifying the use of compact WWTP technology, this has not always been the case. Nevertheless, activated sludge treatment technology has a proven track record for operation, can be easily upgraded, and is capable of achieving performance targets within a wide range of influent conditions and effluent standards.

A prime example of the equipment-based focus can best be illustrated at Bac Thang Long WWTP (Hanoi) in which the 42,000m^3/day WWTP was constructed without any supporting sewerage collection system. Designed to serve a surrounding resident population of 150,000, the treatment plant was to receive flow from a combined sewer system to be constructed through funding from the local authorities. Unfortunately, construction of this collection system did not proceed and, as such, there was no flow to treat when the WWTP was completed. Ultimately, a pipeline was constructed from a nearby industrial park WWTP and primary treated wastewater was "imported" for re-treatment at Bac Thang Long, evidently to lessen the negative public relations associated with this ineffective infrastructure investment. The current utilization of the Bac Thang Long WWTP stands at 16 percent, based on the re-treatment of the diverted 7,000m^3/d of pre-treated industrial wastewater.

Lessons learned in this above example: Donors should participate in funding projects which involve complete sanitation systems, inclusive of treatment plants, sewerage systems, pumping stations and household connections, to ensure project effectiveness. Otherwise, there is significant risk of the poor investment example of Bac Thang Long being repeated elsewhere.

A different approach to treatment technology selection is recommended, favoring technologies which are appropriate for the specific location and have low operation and maintenance costs, in order to lessen the financial burden placed on the local authorities. The focus of donors should be more on a whole of system approach, inclusive of treatment, sewerage and household connections. Good examples of these are the smaller wastewater treatment systems funded by the Finnish International Development Agency (FINNIDA) in northern Vietnamese towns, where site conditions allowed the development of more simplified wastewater solutions. These are projects which favor site-appropriate treatment technology utilizing stabilization ponds and baffled septic tanks followed by constructed wetlands, all having significant land requirements that may not be available in more densely populated areas.

Larger wastewater systems, such as those funded by the Danish International Development Agency (DANIDA) in Da Lat and Buon Ma Thuot, were based on technologies using Imhoff tanks/trickling filters and stabilization ponds, respectively. These less complex technological choices have long-term consequences on the financial sustainability of the constructed works, as they impose less financial burden on the operator. s. However, these technologies require relatively large footprints and produce inconsistent results with respect to removal of nutrients. Whereas the covered anaerobic ponds in Da Nang were a low-tech solution, they may not have been the most appropriate choice considering the site specific conditions of limited land areas and encroaching residential population. Additionally, these ponds do not effectively remove nitrogen and require an additional treatment stage to meet the national effluent standards in terms of nutrient removal.

An example of the use of appropriate treatment technology was the recent decision by the City of Thanh Hoa, supported by ADB, to select stabilization pond technology, to keep the process simple and affordable. This decision was highly supported by site-specific conditions which included land availability, anticipated weak influent wastewater conditions and limited human resources for operation of more complex WWTPs. Such actions by local governments and donors to promote the use of appropriate technology can have a positive influence on the sustainable growth of the sanitation sector in Vietnam, as these investments are usually better adapted to the specific application.

Selection of appropriate treatment technologies. Wastewater treatment is a relatively young industry in Vietnam, with the first WWTP being commissioned in the year 2005. The local government authorities, their representative project management units and decision-makers generally lack experience in the sanitation sector. This is completely understandable given the recent development of the sector. However, this lack of awareness underscores the need for increased capacity building, training and greater exposure of these decision-makers to the sanitation sector, enabling them to make better-informed decisions in terms of application of wastewater technologies in their specific locations.

One of the risks with the lack of experience of local authorities and decision-makers is that they may not be in a position to make decisions on treatment technology based on an evaluation of objective factors such as achieving effluent standards, land availability, investment costs and long-term O&M costs. Decisions may be made based on suppliers' claims, technologies which have been used in other, not necessarily similar, locations and what has become 'popular' in the country. This can result in potential exclusion of other potentially more appropriate technology choices. No single treatment technology should be applied universally; otherwise, there could be significant issues with ineffective or inefficient utilization, as well as issues with long-term sustainability.

The above decision-making process can be best characterized by the utilization of the advanced sequencing batch reactor (ASBR) technology, which has experienced a strong surge in "popularity" in recent years. Within the next five years, there will be at least ten new urban WWTPs based on this technology type. The ASBR technology offers some very significant advantages, for example, in terms of a small site footprint and nutrient removal capability, making it suitable for application in an urban environments and where effluent standards demand high levels of nutrient removal. However, currently the ASBR technology is being promoted as a suitable technology for all applications, both for the large cities and for provincial cities and towns, as well as for all process needs, regardless of the prevailing effluent standard or influent conditions, site availability or limited local resources for operations.

Weak influent conditions in terms of organic loading and seasonal variations that can result in inadequate organic loading to biological processes do not appear to be a factor in the decisions being made to select this technology type. Similarly, application of the oxidation ditch activated sludge technology also appears to be gaining increased popularity in provincial towns in Vietnam, again raising the question as to whether this is the most appropriate use of technology for the specific application.

Lessons learned. Local decision-makers should have sufficient technical knowledge of relevant sanitation issues so as to be capable of making informed technical decisions. This will require increased capacity building of the local authorities during the early stages of project development, such that this knowledge can be later applied to the decision-making process when needed.

Treatment performance. How each of these various types of current treatment technologies perform has been more a function of the specific quality of the influent wastewater received for treatment. The average influent and effluent conditions for each of these 17 WWTPs has been recorded for a number of indicator pollutants. A summary of yearly averages from each WWTP having recorded data is presented in Table C2. This table also indicates the method of collection of influent wastewater, categorized as being either combined or separate sewer collection.

Using BOD as a reference point, the information presented Table C2 illustrates that WWTPs receiving wastewater from collection systems based on the use of CSS receive influent wastewater with an organic loading in the average range of 31-135mg/l BOD, whereas for those systems based on SSS, the average organic loading is much higher at 336-380mg/l for influent BOD.

Again using BOD as an indicator, the removal of organic loading as measured by effluent BOD illustrates that for CSS-based systems, those WWTPs that are governed by Class B effluent standards (limit 50mg/l), produce a BOD effluent quality ranging from 3-38mg/l, whereas for SSS-based systems, WWTPs produce a BOD effluent quality ranging from 14-45mg/l. All these wastewater systems therefore meet the effluent standards for BOD, regardless of the wide range of influent BOD conditions experienced between CSS and SSS-based delivery systems or the type of wastewater treatment technology applied.

More critical is the removal of nitrogen, ammonia and total nitrogen. Class B standards require an effluent standard of 10mg/l and 40mg/l respectively for ammonia and total nitrogen. For ammonia and total nitrogen measured from CSS-based WWTPs, the average treated effluent concentrations range from 1-3mg/l (NH_4-N) and 7-21mg/l (TN), whereas for SSS-based WWTPs, the average treated effluent ranges from 26-32mg/l (NH_4-N) and 8-23mg/l (TN). Influent conditions for the CSS-based WWTPs were typically much lower for ammonia (1-28mg/l) and for total nitrogen (11-44mg/l) than those received at SSS-based WWTPs, as will be highlighted below.

This comparison highlights a performance problem with attaining ammonia limits for the SSS-based WWTPs in Da Lat and Buon Ma Thuot. The problem in Da Lat is primarily attributed to very high (68mg/l) influent loading of ammonia received at the WWTP and the inability of the primary/secondary treatment system to effectively treat levels which are nearly double the concentrations assumed during the design of the facility. At Buon Ma Thuot, in which a more average influent ammonia level of 36mg/l is received, the natural process of stabilization pond treatment cannot reliably achieve the mandated effluent standards, requiring the use of another treatment step, such as constructed wetlands, to remove ammonia to designated limits. Disinfection, or the removal of coliforms from the treated effluent, is practiced with mixed results in Vietnam. Although there is a stated limit for coliforms levels, as measured in MPN/100ml, WWTP effluent for facilities visited were rarely monitored for coliforms. Facilities for disinfection were provided as follows for the WWTPs surveyed:

a. Chlorine dosing followed by contact chamber (7 sites);
b. UV disinfection (1 site);
c. Maturation ponds (5 sites); and
d. None provided (4 sites).

For disinfection by chlorination, two of the facilities, Bac Thang Long and Bac Giang, chose not operate their equipment. The other three operable systems were in Hanoi (two sites) and in HCMC at the large Binh Hung WWTP.

Only the new Yen So WWTP in Hanoi utilized UV disinfection. This technology requires a high quality effluent to be effective, as increasing turbidity will lessen the effectiveness of the UV penetration and resulting disinfection. Given the level of treatment offered at Yen So, the use of UV may be appropriate and does not contribute to the creation of undesirable chlorine compounds, as experienced with chlorination-based systems.

Five sites utilized maturation ponds as a final disinfection step. Four of these sites are preceded by mechanical secondary treatment stages, such as trickling filters, aerated ponds or SBRs. While maturation ponds do in fact effectively reduce coliforms in a natural, non-chemical manner, the final output cannot be closely controlled and is subject to varying environmental conditions. As such, effluent disinfected in this manner may experience wide variations in coliforms concentration and may experience difficulty in achieving the established limits in accordance with the applicable effluent standard.

Four sites did not provide a disinfection process in their process flow train, so these sites do have not the ability to remove coliforms other than incidentally during the process of treatment of organic loads.

Table C2: Treatment Performance Indicators (by December 2012)

No	City	WWTPs	Sewage system	Treat. Process	BOD (mg/L)		COD (mg/L)		TSS (mg/L)		NH_4-N (mgN/L)		T-N (mg/L)		Applicable Eff. Std.
					Inf.	Eff	Inf.	Eff.	Inf.	Eff.	Inf.	Eff	Inf.	Eff.	
1	Hanoi	Kim Lien	CSS	A2O (AS)	94	11	189	22	86	6	18	-	44	16	TCVN5945-2005, B
2		Truc Bach	CSS	A2O (AS)	94	12	191	24	91	5	-	-	39	15	TCVN5945-2005, B
3		Bac Thang Long	CSS	A2O (AS)	60	9	115	17	57	5	-	-	44	13	QCVN40-2011, B
4		Yen So	CSS	SBR (AS)	45	10	132	24	51	10	28	0.5	34	8	QCVN40-2011, A
5	Ho Chi Minh City	Binh Hung	CSS	Aer/Mat Ponds	42	3	135	30	103	7	-	-	11	7	QCVN14-2008, B
6		Binh Hung Hoa	CSS	CAS	78	10	203	50	49	18	18	3.3	-	-	QCVN14-2008, B
7		Canh Doi – Phu My Hung	SSS	OD (AS)											
8		Nam Vien – Phu My Hung	SSS	A2O (AS)											
9	Da Nang	Hoa Cuong	CSS	Ana. Pond	67	33	123	66	61	23	-	-	24	19	QCVN40-2011, B
10		Ngu Hanh Son	CSS	Ana. Pond	34	29	64	47	28	16	-	-	16	13	QCVN40-2011, B
11		Son Tra	CSS	Ana. Pond	39	26	70	50	40	19	-	-	18	14	QCVN40-2011, B
12		Phu Loc	CSS	Ana. Pond	101	38	178	76	73	23	-	-	28	21	QCVN40-2011, B
13	Quang Ninh	Bai Chay	CSS	SBR (AS)	36	20	80	32	195	11	1.3	1	0.1		-
14		Ha Khanh	CSS	SBR (AS)	45	23	68	68	41	35	1.1	1	0.2		-
15	Da Lat	Da Lat	SSS	Imhoff Tank/ TF	380	14	604	65	792	82	68	26	95	8	QCVN24-2009, B
16	Buon Me Thuot	Buon Me Thuot	SSS	Stab. Ponds	336	45	564	98	285	76	36	32	93	23	QCVN24-2009, B
17	Bac Giang	Bac Giang	CSS	OD (AS)	-	-	120	25	-	-	0.2	0.1	-	-	QCVN14-2008, B
	QCVN40:2011/BTNMT, A class					**30**		**75**		**50**		**5**		**20**	
	QCVN40:2011/BTNMT, B class					**50**		**150**		**100**		**10**		**40**	

3. The Impact of Weak Influent Quality on Application of Treatment Technologies

Wastewater is collected by two methods in Vietnam, including the collection (including drainage) in combined sewerage systems (CSS) and the collection (excluding drainage) in separate sewerage systems (SSS). The distinction between these two collection types is significant, as the inclusion of drainage with the CSS-based system results in a much more dilute influent flow when received at the downstream wastewater treatment plant. This is evidenced in the data collected from WWTPs, which illustrate that the influent flow organic loading (BOD) for CSS-based systems range on the average from 31-135mg/l, with an overall flow-weighted average of 67.5mg/l.

Worldwide, CSS-based systems with underground sewers and interceptors have been shown to deliver more normal (higher) concentrations of influent BOD loading than is being experienced in Vietnam. The different situation in Vietnam appears to be the result of the use of large drainage canals for CSS which allow sedimentation of solids, thus reducing the BOD concentration. The consequent release of ammonia, due to the anaerobic digestion of the settled solids, results in elevated ammonia levels.

Household connections to public piped sewerage systems are an essential component for any sewerage system, whether it is based on combined or separate flows. These connections allow the household's wastewater to be conveyed offsite, precluding the need for on-site disposal, which is often difficult due to limited land area and poor underlying soil conditions.

The majority of households located in urban areas of Vietnam utilize septic tanks for on-site treatment of wastewater prior to discharge of the treated effluent off-site. This on-site treatment provides for basic sedimentation of the wastewater, removing those solids that could otherwise cause operational problems if allowed to enter the downstream combined sewerage systems. The sludge settled in the septic tank is anaerobically digested and must be periodically removed to ensure functionality of the septic tank system and to prevent overload. An overloaded septic tank greatly reduces the effectiveness of treatment and can contribute to solids deposition in downstream sewers and odour generation.

For household connections to separate collection systems, the household can eliminate the septic tank, as was done in the Buon Ma Thuot wastewater system. This is made possible due to the hydraulic conditions in the pipeline which keep the solids suspended in the pipe, thus minimizing the effects of solids deposition. Additionally, separate systems are constructed to be totally enclosed piped systems, with little opportunity for odor generation.

The low influent quality for wastewater collected by combined sewerage systems (CSS) presents unique problems for the operators of the downstream wastewater treatment plants, particularly those based on biological treatment systems. These problems can be no better highlighted than at the Yen So WWTP in Hanoi. The catchment area tributary to the Yen So WWTP generates combined sewerage flow that then discharges to the Kim Nguu canal and onto the WWTP, where a portion of the canal flow is withdrawn for treatment. As the Kim Nguu canal flows through the City, CSS drainage channels and pipelines discharge collected flow into the canal. As the canal velocity is slow, solids contained in the combined sewerage settle to the bottom of the canal and are anaerobically digested. This has two effects, first, to reduce the organic loading in terms of BOD to the WWTP and second, to increase the ammonia content as a result of the fermentation process in the canal bottom.

At Yen So WWTP, the effect of this reduction in BOD and increase in ammonia is evident, with influent BOD averaging 45mg/l, whereas influent ammonia levels average 28mg/l. As the normal C:N (carbon to nitrogen ratio) needs to be at least 2.73:1 to drive the denitrification process, Yen So WWTP has a carbon shortage, at times reducing this critical ratio below 1.0. To keep the process functioning properly in terms of achieving the nitrogen effluent standards, the operators at Yen So WWTP must add a carbon source to the WWTP secondary influent in order to create the correct chemical balance.

If the collection system included an interceptor pipeline along the Kim Nguu Canal to eliminate discharge to the canal, then the problem with C:N imbalance would likely not occur. Furthermore, the elimination or reduction of combined sewage flow to the Kim Nguu Canal would have positive effects in terms of improving the environment of the Kim Nguu Canal catchment as it flows through Hanoi. The lack of an interceptor system in Hanoi is another example of a disconnection between sewerage and treatment. Whereas there was considerable interest to spend about USD 300 million in the construction of the Yen So WWTP, there was apparently far less interest in the implementation of a sewerage collection network which could actually have created a better environment for Hanoi by improving the water quality of the Kim Nguu Canal. This would have also contributed to more sustainable operating conditions for the Yen So WWTP.

Lessons learned. Wastewater systems should be considered only as a complete process, including household connections, sewerage, pumping stations and a wastewater treatment plant. Failure to acknowledge the importance of any one or more of these components will lead to project ineffectiveness and unsustainability

4. Impact of Effluent Discharge Requirements on Application of Treatment Technologies

Wastewater treatment in Vietnam is regulated by the Government of Vietnam's mandated effluent standards which establish limits for key pollutants based on the specific utilization of the downstream receiving water. Normally, these standards are divided into "A" and "B" categories, with the "A" category applied to those WWTPs discharging to receiving waters which later become sources for water supply downstream. Category "B" is for discharge to receiving waters which are not subsequently used as water supply.

The majority (16 out of 17) WWTPs currently operating in Vietnam fall under the Category "B" designation. While this category establishes attainable limits for most constituents, such as BOD, COD and TSS, the limits established for nutrients, in particular those of ammonia and total nitrogen levels in the treated effluent, can be difficult to achieve depending on specific situation. The most recent limits, as created by the QCVN 40:2011, Category "B", establish the ammonia and nitrogen limits at 10mg/l and 40mg/l respectively. Such limits, while not as strict as in some countries, can create problems in that the treatment processes selected may be required to both nitrify (remove ammonia) and denitrify (remove total nitrogen), depending on the influent wastewater ammonia and nitrogen concentrations.

As mentioned in the previous section, the experience with the Yen So WWTP in Hanoi has highlighted the significance of the total nitrogen limit, as the operators are required to add considerable qualities of carbon in the form of processed sugar, just to allow the denitrification reaction to occur, so as achieve the design total nitrogen limit of 10mg/l. To create the chemical conditions necessary to reduce TN by less than 10mg/l, it is necessary to purchase an additional carbon source.

The nutrient limits established by current effluent standards are the main drivers for selection of certain activated sludge treatment technologies, such as SBR and OD, as these technologies will both nitrify and denitrify biologically by design within the process tank itself. The effluent limits with respect to nutrients may preclude the use of simpler technologies, as these technologies cannot reliably achieve specific ammonia and total nitrogen limits. This situation limits the technology selection to relatively high technology solutions, as promoted by suppliers of these products, and in accordance with what has generally been used in the past. Of course other justifications, such as limited footprint, reliability, aesthetics and odour control, all play a role in the selection, particularly when the application is in a densely-populated urban area.

5. The Future of Wastewater Treatment Technologies in Vietnam

Rapid growth of the sanitation sector over the next five years is under way, with 32 WWTPs now either in design or under construction (see Appendix B, Table B2)[21].

Given the above summary of "in progress" WWTPs, it is evident that around 80 percent of the future WWTP installation will utilize some form of activated sludge technology. This apparent focus on activated sludge technologies for future WWTPs is a concern in terms of application of appropriate technology, especially when considering that 17 of these 25 activated sludge facilities will be located in provincial towns and cities, outside of the four largest cities of Hanoi, Ho Chi Minh City, Hai Phong and Da Nang. Selection of any technology must be based on a number of factors including ability to achieve effluent standards, site suitability, investment costs and operations costs.

Whereas site availability certainly impacts the decision to select compact, more complex WWTP technologies for the densely populated large cities, that same argument cannot necessarily be made for application of these technologies in provincial towns and cities. For many of these cities, urban development continues for no more than 3-5km from the city center after which agricultural areas or paddy fields predominate, with little impact of resident population. The value of land in these outlying agricultural areas is far less than land prices in the core city, allowing for alternative solutions for treatment technology, which are based on the use of larger sites, such as pond technologies or constructed wetlands, subject to that technology achieving prevailing effluent standards.

6. Conclusions and Recommendations

The current wastewater systems (under operation). Combined sewerage systems (CSS), which also allow drainage and rainwater inflow into the system, are utilized for the collection and conveyance of 92 percent of the flow influent to WWTPs currently operating in urban areas of Vietnam. Based on measured influent BOD concentrations to the 13 WWTPs being served by these combined sewerage systems, the flow-weighted influent BOD average is 53mg/l. At this concentration, the sewage received could better be described as drainage. Of these same 13 WWTPs receiving CSS flow, eight are based on the use of some form of activated sludge technology (CAS, SBR, OD, A2O), which constitute a total of 85 percent of the total design flow capacity for those plants receiving flow from combined sewerage systems in Vietnam.

Comparatively, those wastewater systems currently served by separate sewerage systems (SSS) demonstrate significantly different characteristics with respect to BOD concentrations in the influent flow. As noted in Table C2, the average BOD concentration for influent flow received in Buon Ma Thuot and Da Lat WWTPs

[21] Latest information update: newly commenced WWTPs in Vietnamese urban areas: Phan Rang, Ninh Thuan province (design capacity 5,000m^3/day, commenced in 2012), Vinh city, Nghe An province (design capacity 25,000m^3/day, commenced in 2012), Bac Ninh city, Bac Ninh province (design capacity 17,500m^3/day, commenced in 2013), Thu Dau Mot city, Binh Duong province (design capacity 17,650m^3/day, commenced in 2013), Soc Trang city, Soc Trang province (design capacity 13,000m^3/day, commenced in 2013).

is 336mg/l and 380mg/l, respectively. For both of these wastewater systems, all households located within the sewerage service area are connected to the SSS. In the case of Buon Ma Thuot, the households connect directly, without the use of on-site septic tanks. The SSS ensures that sewage generated within the service area will be collected and treated properly, without impact on the drainage canals. By collecting sewage only without drainage, the local authorities have less wastewater to pump and to treat, thus minimizing investment cost.

Conclusion: Highly technical advanced wastewater treatment technologies are currently being utilized on a large scale to treat "wastewater" which could be better classified as drainage. While it could be argued that such WWTPs are intended as a future investment in order to comply with international standards, the current low utilization of these plants raises questions regarding effective use of capital investment. This should prompt discussion as to whether treatment standards and resulting technology selections be staged over time to allow a more reasonable and sustainable evolution in urban sanitation in Vietnam.

"In progress" wastewater systems. There are 32 wastewater systems presently in progress, either in the design or construction phase, all of which will likely to be operational within the next five years. On the basis of sewerage collection, 98 percent of the expected sewage design flow will be collected and conveyed by combined sewerage systems (CSS). Twenty-five of these 32 wastewater systems will utilize WWTPs that will be based on some form of activated sludge technology (CAS, SBR, OD, A2O) and 29 of them will receive flow collected by CSS. If current influent BOD concentrations for wastewater collected by CSS in Vietnam are any indication, this future collected flow will have equally weak influent organic load characteristics. Thus, highly technical wastewater treatment plants are being constructed to treat what could best be described as "drainage."

Conclusion: The majority of future WWTPs based on activated sludge technology will receive flow from combined sewerage systems that have historically generated very weak influent organic loading characteristics. The current practice of treating weak influent sewerage (drainage) by means of highly technical advanced wastewater treatment plants will continue with the ongoing expansion of the sanitation sector in Vietnam. Such practice is not always the most effective use of investment capital and can result in higher operation and maintenance costs once the wastewater system becomes operational.

Recommendations:

1. Development of wastewater systems must include all functional components (household connections, sewerage, pumping stations and wastewater treatment) within the same funded project. Failure to do so will lead to project ineffectiveness and a lack of sustainability.
2. Local authorities should focus their attention on current wastewater systems now lacking viable sewerage components, such as for Bac Thang Long WWTP, Yen So WWTP and Binh Hung Hoa WWTP, so as to construct suitable collection networks to provide more effective utilization of the current investment.
3. Household connections are an essential component to every wastewater system, regardless of whether combined or separate sewers are adopted. Household connections resolve the household's wastewater disposal issue, eliminate the problem with pollution of the groundwater and create better sanitary conditions in the sewerage service area. Connecting to the public sewers increases the organic loading, which creates a more effective use of costly wastewater treatment systems that have typically been designed for much higher loadings.

4. The use of separate sewerage systems for wastewater collection and conveyance should be carefully considered, especially for provincial cities in which traffic concerns relating to construction of sewers do not pose such a problem as they would in the large cities. Use of SSS will more effectively collect sewage (only), minimize the amount collected, increase the effectiveness of the downstream WWTP, and improve the environmental sanitation in the sewerage service area by minimizing odors long associated with collection of sewerage by means of CSS.
5. Wastewater treatment technologies must be selected based on influent wastewater characteristics, effluent standards, receiving water assimilation properties and specific site constraints. Every effort should be made to select the most appropriate technology based on the simplest level technology necessary to achieve the process performance requirements. Selection based on “popularity” of the technology, not considering-technical factors, should be avoided.
6. Local authorities who will become involved with the management and decision-making for sanitation projects should be provided with capacity building, training on technical matters relating to the urban sanitation sector, and exposure to similar projects in Vietnam and regionally. Such capacity building will increase the awareness and technical capability of these decision-makers, allowing for improved decision-making.
7. Capacity building in terms of training of future staff responsible for operation of all types of WWTPs, from the most simple to the most complex, must be an integral component in any wastewater system program. Training cannot just occur for a brief period and then be expected to create fully functional operations staff. Training must be further supported by mentoring of staff by experts trained for the specific technology, such that this technology transfer can occur while the staff is actually engaged in operation of the WWTP. This mentoring period should occur over a period of at least two years, preferably longer, if the technology is more complex.
8. A phased approach should be considered for application of effluent standards to: allow selection of lower technology treatment solutions initially, with effluent standards increasing over time -- as the sanitation sector matures public perception of sanitation issues becomes more acute, and cost recovery improve -- so as to allow more advanced wastewater solutions in the future.

CASE STUDY 2: WASTEWATER TARIFF AND COST RECOVERY

1. Introduction and Scope

This case study will examine the state of cost recovery in Vietnam with respect to those urban sanitation companies responsible for managing the 17 wastewater systems currently in operation. This case study will be organized as follows: (a) define what constitutes cost recovery and its significance in Vietnam; (b) identify the operating costs for each of the 17 wastewater systems currently in operation in urban areas of Vietnam; (c) review how fees for wastewater services are regulated, collected and to provide an overview of the revenues currently being generated in Vietnam in this regard; (d) summarize the actual level of cost recovery achieved by urban sanitation companies in Vietnam; and (e) offer recommendations as to how the recovery of costs associated with the operation of urban wastewater management systems could be improved in the future.

2. The Definition and Role of Cost Recovery to the Financial Sustainability of Wastewater Management Systems

Cost recovery for urban sanitation can be simply defined as the degree to which costs incurred during the operation and maintenance of wastewater management systems are being recovered through revenues generated by fees charged to those customers receiving the benefit from the services provided.

The resulting financial sustainability and viability of wastewater management systems can be measured by the degree to which the recovery of operation and maintenance costs are achieved through this collection of revenue. However, in Vietnam, cost recovery through the collection of (wastewater) fees constitutes only a fraction of the total costs incurred, with significant levels of government subsidy required to support ongoing operations. Given the current regulatory framework regarding wastewater fees, and local government's seeming reluctance to charge, this practice of significant government subsidy is expected to continue.

Since the wastewater management systems in urban areas in Vietnam currently operate with substantial government support, the viability and long-term functionality of these systems are very much dependent upon the commitment of the local authorities to the continuing operation of the system. Thus, a strong feeling of "ownership" of the government authorities, with regard to their wastewater systems, would create that sense of commitment, both financial and political, which would be the catalyst for the successful operation of the enterprise.

3. Identification of Operating Costs for Wastewater Systems Now Operating in Vietnam

The operating costs for wastewater systems include O&M for the sewerage system, sewage pumping stations and wastewater treatment plant(s). These costs can vary significantly depending on the type of sewerage technology, CSS versus SSS, the number of pumping stations and the type of technology utilized for wastewater treatment. The level of service provided for sewer maintenance was found to vary widely, ranging from only responding to emergency demands to proactive routine maintenance, with the condition of the sewerage works consistent with level of service provided. Highly mechanized WWTPs, which constitute the majority of applications for the sites visited, have higher operating costs due to higher power requirements, labor resources and chemicals.

The O&M costs for a representative group of WWTPs can be compared from the data in Table C3, highlighting certain differences between alternative technical solutions:

TableC3: Comparison of O&M Costs from Currently Operational WWTPs

WWTP Location	Sewer Type	Treatment process	Cost (VND/m³)	
			Sewer	WWTP
Kim Lien	CSS	A2O (AS)	2,000	4,700
Truc Bach	CSS	A2O (AS)		4,400
Bac Thanh Long	IZ Effluent	A2O (AS)		7,100
Yen So	CSS	SBR (AS)		1,506
Binh Hung	CSS	CAS		1,200
Binh Hung Hoa	CSS	Aer/Mat Ponds		963
Canh Doi, PMH	SSS	Ox. Ditch (AS)	N/A	N/A
Nam Vien, PMH	SSS	A2O (AS)	N/A	N/A
Son Tra	CSS	Cov. Anaer. ponds	1,191 (combined)	
Hoa Cuong	CSS	Cov. Anaer. Ponds	Included above	
Phu Loc	CSS	Cov. Anaer. Ponds	Included above	
Ngu Hanh Son	CSS	Cov. Anaer. Ponds	Included above	
Bai Chay	CSS	SBR (AS)		2,918
Ha Khanh	CSS	SBR (AS)		3,276
Da Lat	SSS	Imhoff Tank/ TF	4,110 (combined)	
Buon Ma Thuot	SSS	Stab. Ponds	1,800	950
Bac Giang	CSS	Ox. Ditch (AS)		1,039

While the above table shows only those values which could be obtained from the operating utility, they do reflect a trend in WWTP operation costs, namely:

a. More complex technologies generally require higher operation costs;

b. Size matters. The larger WWTPs, such as Yen So and Binh Hung, while deploying higher technological solutions, have lower costs as afforded by their economy of scale; and

c. Simple WWTP technologies generally require lower operation costs.

4. Review of Wastewater Fee Regulation, Collection and Revenue by Urban Sanitation Companies

Regulatory Aspect. The application of fees, related to wastewater and environment protection, are regulated by Decree 88 and Decree 67.[22] Ever since Decree 88 came into being in year 2004, there has been significant confusion at local government levels regarding how these two decrees, which share common

[22] During preparation of this Report, the Decree 25/2013/ND-CP was issued on March 2013 replacing Decree 67. Further, in May 2013 the Circular 63/2013-TTLT was issued guiding implementation of Decree 25. Decree 25 has distinguished the environmental protection (EP) fee from the wastewater fee. The EP is to be collected from industrial users and from households discharging wastewater to the environment. For domestic wastewater, the wastewater system operator and the households who are not connected to a piped water system have to pay EP fee which should not exceed 10% of local water tariff. Since 10% of the water tariff is far below the wastewater tariff which should follow the principle of recovery of wastewater system O&M costs, this rule may not encourage the connection of households to the wastewater network. Separately, the Decree 88 is being revised and will be re-named "tariff for wastewater collection and treatment services" instead of wastewater fee. This tariff is to be collected from all users of wastewater services.

boundaries for generating revenue to recover cost, should be applied. This confusion is generated by the regulations governing the application of a percentage fee on the water tariff for all water customers, based either on Decree 67 or 88.

Wastewater Fee (Decree 88) and Environmental Protection Fee (Decree 67)

There is a lack of clarity on roles and overlapping of responsibilities between DONRE and water supply companies in terms of establishing and collecting wastewater fees. In a large number of instances, water supply companies are already collecting wastewater fees. In such circumstances, it could be perceived that the Environmental Protection (EP) Fee implemented by DONRE overlaps with this wastewater fee already implemented by the water supply companies. To some extent, a similar confusion appears to exist with respect to industrial estates and firms located within those industrial estates.

As has been noted by all urban sewerage companies, a significant purpose of Decree 67 was to create incentives for pollution control and "to limit the environmental pollution caused by wastewater", so the fee should reflect the pollution loads. However, in the urban sanitation sector, the EP fee for sewerage is calculated on the basis of less than 10 percent of the water supply charge, which is clearly smaller than wastewater fee defined by Decree 88. Since the non-connected households who discharge wastewater directly to the receiving environment will contribute more to water pollution, it appears that Decree 67 has been less than effective in achieving either pollution control or revenue generation.

While Decree 67 has implemented an EP fee for regulating non-connected households who discharge wastewater discharge into receiving surface water, a centralized WWTP, which also discharges directly to the receiving surface waters, does not have to pay an EP fee.

As water tariffs range widely between large cities and Provincial cities and towns, the actual amount of revenue received can vary widely. The following wastewater fees (or percentages applied) were representative of the current status of revenue collection in Vietnam, all based on water use:

- Hanoi – VND 450/m^3
- HCMC – 10 percent of water tariff
- Da Nang – 21 percent(2012) increasing to 25 percent(2015) of water tariff
- Quang Ninh – VND 510/m^3
- Da Lat – VND 1000/m^3 (2011), increasing to VND 2907/m^3 (2015)
- Buon Ma Thuot – VND 200/m^3

Revenue is collected by the water supply company in its billings to water supply customers and is typically held by the City or at the provincial level for redistribution to the wastewater enterprises, based on agreed annual budgets. As the amounts received by collection of fees are never sufficient to meet the actual costs of operation, the shortfall is always subsidized from local budgets. Depending on the local authority's level of motivation and interest in the sustainable operation of the wastewater system, this method either operates very well or marginally, as found in some cases.

Problems are encountered when extraordinary repairs and emergencies arise, for which annual budgets are not available. At these times, the operating company must obtain special approval from local authorities for funding, which can often lead to delays in repairs, loss of service and can eventually lead to system failure if the problems are not addressed in a timely manner.

It would be difficult to argue that government subsidies and support provide an effective stimulus for growth and improvement of services in the sanitation sector. For the most part, such subsidies are provided in line with basic budgetary needs, which are more at a subsistence funding level and not designed for expansion or improvement of sanitation services. Currently, the expansion of sanitation services can only be achieved through outside funding as provided by international lenders and donors. Local funds are limited and the priority to expand sanitation services is not evident for most cases noted.

5. Summary of Current Status of Cost Recovery by Urban Sanitation Companies in Vietnam

Cost recovery is not fully achieved at any of the currently operating wastewater systems in urban areas in Vietnam. The degree to which costs have been recovered through application of fees, indicated as a percentage of the cost, is shown below (Table C4) based on data from representative operating authorities.

Table C4: Examples Showing Varying Degrees of Cost Recovery

Operating Authority	Percentage of Cost Recovered
Hanoi Sewerage and Drainage Company	25[1]
Lam Dong WSC (Da Lat)	17.6
UMESC (Buon Ma Thuot)	28.3

Note: [1] For Hanoi Sewerage and Drainage Company, the figure of 25 percent was estimated and provided via an interview. No formal financial figures were provided.

6. Conclusions and Recommendations

Regulatory Reform

As mentioned earlier, there is a sense of confusion in the application of the current Decrees 67 and 88 in terms of levying fees. As this problem is well known, the Ministries responsible for these decrees have taken action to effect revisions intended to reduce the level of uncertainty and confusion. Such action is encouraged as a means to provide a more effective framework for levying fees which better relate to cost recovery. Rather than having the regulations limit the fee charged to a fixed percentage of the water supply tariff, it would be more useful to have a suggested range for such fees, so as to provide the operating authority with the flexibility to charge fees more in line with their costs.

Willingness to Charge

There is a lack willingness on the part of local city or provincial authorities to charge customers at sufficient rates to recover costs. This was most apparent in the case of Buon Ma Thuot, where the operating enterprise enjoys very positive public opinion regarding the sewerage services offered by the company and has households eager to connect once the SSS is expanded in the next Phase. However, even with apparent high customer satisfaction, the local provincial government has not taken positive action to increase the rate of cost recovery, choosing instead to subsidize the operating costs from local budgets. This lack of willingness to charge could be linked to a system which has historically been State-managed with deficits subsidized. Pressure on local budgets may change this view, but this will take time and political will to achieve. If cost recovery is to occur in a meaningful way, this prevailing political culture of government subsidy will need to be replaced by a more financially sustainable willingness to charge fees to secure necessary revenue to recover costs.

Improving Public Awareness of the Benefits of Sanitation Services Provided

To have effective cost recovery, there must be willingness on the part of the customers served to pay for that service. Such willingness will occur only if those customers are aware of and can appreciate the benefits gained for receiving sanitation services. An information, education and communication campaign, designed to increase customer knowledge of the public wastewater system, the benefits offered to the customers served, and to improve the understanding of sanitation practices needs to be implemented. This has been very effective in the sanitation projects of Da Lat and Buon Ma Thuot, resulting in increased demand for services in those areas not presently served. Customers presently served by these systems generally have a heightened state of awareness of sanitation issues and appreciate the benefits they receive. Creating this type of understanding for the customers establishes the ideal environment for willingness to pay for services provided.

Keeping Operating Costs at Reasonable Levels

As with any business, the operation of a wastewater system should be carried out efficiently, as all costs will ultimately be borne by the consumer in the form of fees charged, generally with some additional government subsidy required. This need for efficiency should not be mistaken to mean that the sanitation company should cut corners or omit necessary O&M activities, as such efforts enhance the customer's perception of benefit provided and the customer's willingness to pay for those benefits. To instill customer confidence and to maximize the extent of cost recovery, the wastewater system must be conceived and designed appropriately for the application and specific location such that overly complex, or resource dependent processes are avoided, unless absolutely necessary for the specific application. The minimization of operating costs (e.g., electrical power, manpower, chemicals, etc.) by selection of appropriate technology during the design stage will have long-lasting benefit and effect during the many years of operation that follow implementation. Thus, effective cost recovery begins with the minimization of costs through application of appropriate design.

Willingness to Pay

With well-informed customers, as made possible by an effective IEC campaign and a well-operated wastewater system providing discernible benefit to the customer through quality service, conditions become favorable for a willingness to pay for these services as they will be perceived as having tangible value. With customers willing to assume more of the cost burden for operating the wastewater system, the sanitation company will become less dependent on local government subsidy, creating improved opportunity for cost recovery and financially sustainable operations.

CASE STUDY 3: HOUSEHOLD CONNECTIONS

1. Introduction and Scope

This case study will examine the role of household connection to sewerage systems in Vietnam, exploring an aspect of urban sanitation which is often misunderstood and neglected, but which is vitally important to the successful operation of any urban sanitation scheme. The case study is intended firstly to define what constitutes a household connection; secondly, to provide background to the current status of household connections in urban areas of Vietnam; thirdly, to answer several basic questions regarding household connections; and finally, to offer recommendations as to how this important aspect of urban sanitation can be improved in the future.

2. Definition of Household Connection to Urban Sanitation Systems

Household connection to urban sewerage networks constitutes the essential piped linkage between the private residential or commercial sewage originator (referred to as “the household”) and the downstream public sewerage network, which collects and conveys sewage for subsequent treatment and disposal. Household connections can be broken into two main categories: those discharging to combined sewerage system networks, which receive both sewage and drainage flows, and those discharging to separate sewerage system networks, which, by definition, specifically exclude drainage flows.

Combined sewerage systems are the most common type of urban sanitation collection type used in Vietnam, with all large Vietnamese cities utilizing this type of system, as well as many provincial towns surveyed as part of this Review. The reason for this widespread use is generally found in economic savings and convenience, as all cities and towns must convey drainage from urban areas to avoid flooding, so the piping network for these drains has generally been established from the time the neighborhood road system was originally constructed. As houses were constructed on these streets, they needed a method for discharge of sewage generated on-site. Unless soil conditions were suitable for percolation of wastewater beneath the house, this flow had to be disposed of offsite. The obvious choice for offsite disposal was the drainage channel or pipe constructed in the sidewalk/street areas in front of the house. These connections were and continue to be carried out on an informal basis, without permit or city inspection. For this reason, it is not possible to determine with certainty just how many households are actually connected to the system.

In the case of household connections for the city of Da Nang, there is an ongoing pilot program for connecting households in the core urban area to the CSS. In this case, a tertiary pipeline of D150 is constructed in the sidewalk area and households are connected, via a household junction box located just outside the house itself, to the public tertiary pipeline. This tertiary sewer is then linked at frequent (50-100m) intervals to the CSS network.

All houses constructed in Vietnam are required by building code to have on-site treatment systems, typically septic tanks, which provide sedimentation of the household wastewater. This is an important point to note with regard to connection of that household to the CSS, as the sewage discharged from the household has been pre-settled by the on-site septic tank system, thus reducing the organic solids which could create operational problems in the downstream CSS.

Combined sewerage drains have historically been constructed as minimum sloped or flat drains, which encourages the sedimentation of any solids or solid waste that enters the system. Thus, it is imperative that any household considered for connection to a public CSS must have an installed and operational on-site treatment system. Although the operational aspect of these on-site systems will be the topic of a separate case study in terms of septage waste management, it suffices to say that if a septic tank is not maintained with regular frequency, it will lose effectiveness in terms of sedimentation of solids and eventually not provide the pre-treatment required for discharge to the public CSS.

Thus in summary, households connecting to a public CSS will be required to have a constructed, functional on-site treatment system (septic tank). Pre-treated wastewater will be discharged from the septic tank either directly to the public combined drain or, in the case of recently built systems, to a sewer located in front of the residence or a tertiary sewer collection pipeline via an individual household junction box. In either case, this connection is typically constructed of D110 PVC piping and installed on an informal ad hoc basis, typically without permit, unless it was part of special connection program as was previously mentioned for Da Nang.

Separate sewerage systems (SSS) are less common in Vietnam, but growing in interest and popularity particularly in newly developed peri-urban areas, as the SSS exclusively collects sanitary sewage only into a closed piped network. This has significant benefit in terms of mitigating odors in the public sewerage network, as the access point for SSS is limited to the connected households themselves, which means that solid waste and rain water are specifically prevented from entering the SSS. Mitigating foul odors from urban sanitation systems creates value that can be directly perceived by the local area residents.

In Vietnam, the only currently operational SSSs are located in the cities of Da Lat and Buon Ma Thuot, both of which became operational in year 2006. A smaller SSS system located in Chau Doc in the Mekong Delta area became operational in year 2011 and is still in the process of connecting households. For this case study on household connections, the SSS networks for Da Lat and Buon Ma Thuot offer much in the way of information, experiences and lessons learned in terms of the connection of households to SSS networks.

Separate sewer systems are designed based on three stages of collection, inclusive of primary, secondary and tertiary sewer pipelines. Tertiary sewers are constructed in the sidewalk area (if space is available) in front of each household. These tertiary sewer pipes are sized at D150-D200 and receive flow from each household, first flowing through a household junction box located in the public area just outside the house itself, and then flowing into the tertiary sewer pipe by means of a “wye” pipe fitting connection. The tertiary sewers are periodically connected to the secondary sewer every 50-150m, keeping the depth of the tertiary sewers relatively shallow.

The secondary sewers are constructed within the roadway, with pipelines sized at minimum D200 and access for maintenance provided by installation of D1000-D1200 manholes, spaced every 50-60m. The tertiary pipelines are typically connected to the secondary pipelines at these access manholes, facilitating access to the connecting pipelines as well.

Lastly, the secondary pipelines are finally connected to large primary sewer pipes, D300 and larger, which then convey the collected sewage to the WWTP for treatment and subsequent disposal. The primary pipelines generally function as transfer pipes only, receiving the collected sewage from the secondary sewer network.

By design, the SSS is sized only to receive the sewage generated from connected households, with all rainwater and solid waste excluded. The SSS is designed hydraulically with suitable slope such that the collected sewage is effectively conveyed by gravity flow along the pipeline, thus minimizing problems with sedimentation. A design velocity of 0.75m/second for the sewage transported is generally maintained to minimize solids deposition.

Household connections to SSS will have different requirements than those for CSS networks. One important factor is that the SSS is a totally closed system, designed with pipes sized and sloped to facilitate gravity flow and to minimize the sedimentation of solids. This means that the SSS can receive solids in the sewage without problem, allowing households to discharge their sanitary waste, both black and gray water, without pre-treatment. Thus, a septic tank is not required for households connected to an SSS network. This offers significant advantages to the household, which is then released from the burden of septage management and problems associated with septic tank pumping, plugging and overflow. All organic matter collected from the households is then conveyed to a single, centralized waste water treatment plant (WWTP), offering significant economy of scale to the WWTP operation.

Household connections associated with new home construction are easily connected directly to the SSS by routing the household plumbing to the junction box and then to the tertiary sewer. A septic tank is not required at all for new construction utilizing a direct connection to the SSS. However, in existing households, the connection to the SSS must be cut through the household floor as the kitchen/toilets/septic tanks are typically in the rear of the house and the connection to the SSS is typically located in front of the house. Unless this conveyance pipeline had been earlier installed to accommodate septic tank discharge to a CSS drain, it must be added for connection to the SSS. As existing households will have existing septic tanks, these tanks can be bypassed by simple piping rerouting or the discharged flow from the septic tank can be routed to the new SSS. However, this latter arrangement requires that the septic tank stay in service and be maintained routinely, with the associated cost of operation.

Thus in summary, households connecting to a public SSS can connect their collected sanitary wastes directly to the SSS, without pre-treatment. The need for an on-site septic tank system is eliminated, as the SSS can receive sewage without pre-treatment. Existing households will need to make sewer piping changes within the household to allow bypass of the septic tank, if desired, or the septic tank can continued to be utilized. New household construction can connect directly to the SSS without having to construct a septic tank.

The household connection is implemented by installing piping under the house floor, connecting the collected household sanitary waste to the junction box just outside the house structure. From there, the household pipe is connected to the tertiary sewer network (if available) or alternatively to the secondary sewer directly if limited space does not allow the construction of a tertiary piping network. House connections to a SSS network must be regulated by permit to be taken out by the household for construction of the connection. This is necessary to ensure the household connection is performed correctly and with high quality, and most importantly, that the internal household collection piping does not mistakenly incorporate any non-sanitary connections such as roof drains, which if connected, could cause the SSS to surcharge during rain events.

3. Current Status of Household Connections to Urban Sanitation Systems in Vietnam

Household connections to public sewerage systems in Vietnam can be most clearly characterized by two groups: (a) those with informal connections made on an ad hoc basis by the household to the combined sewer system in front of the house; and (b) those with formal connections made by the households to a separate sewerage system carried out by permitted construction activity and monitored for standards and quality, with the connection made to a tertiary sewer pipeline installed in the sidewalk area. The differences between these two types of household connections are significant.

Household connection to the combined sewer systems. The informal connection to the CSS is generally unregulated, not inspected and carried out with undetermined quality. Such connections would typically not include a junction box to facilitate inspection of the effluent leaving the household or to provide an access point for cleaning the pipeline in either direction. The household is only concerned with the disposal of sewage from the household. What happens after it leaves the household is of lesser interest. Furthermore, as the household must also discharge drainage collected by roof drains and outside drains, these flows may also be carried in that same pipeline connection to the combined drain. Given the informal nature of this connection, there are few records concerning how many households are actually connected to CSS networks. However, given that many densely populated urban areas such as Hanoi and HCMC are underlain with less permeable soil types, there is likely strong interest on the part of the households in these cities to connect to the combined sewer drains, as disposal on-site through soak-away pits draining into impermeable soils would be problematic. Therefore, it could be assumed that a high percentage of households in these cities, 90 percent or more, will have an informal connection to neighborhood drains, allowing for unrestricted disposal of the household sewage effluent.

The exception to this case would be in the city of Da Nang, a location where the sandy, highly permeable soils allow easy disposal of household septic tank effluent by means of a soak-away pit. Of course, this method of disposal, if practiced in densely populated city areas, will have significant impact on the underlying groundwater table. For this reason, the City of Da Nang is conducting a household connection program to encourage households to connect to the combined drainage system by means of tertiary collection pipes built by the program in participating neighborhoods. However, this program is relatively small scale (just 800 participating households), so it is really only a demonstration in preparation for a much larger, city-wide program. Currently in Da Nang, the actual level of household connections is low city-wide due to the relative ease of disposal on-site. This is evident in the concentration of pollutants found in the influent sewage to the WWTP, as conveyed by the combined sewerage system. This influent sewage comprises some of the weakest concentration of pollutants found in all the cities surveyed by the Review, indicating a low rate of household connection to the CSS.

Elsewhere in the provincial cities and towns in Vietnam having combined sewerage systems, the situation is much the same, dependent on subsurface soil conditions. If soil conditions are poor, restricting disposal of sewage effluent on-site, then the household will take whatever action possible to dispose off-site, with the first option being the informal connection to the combined sewer drain in front of the household. Again, the actual percentage of households connected in this informal manner cannot be accurately determined, but it can be safely assumed that if the household has no choice with regard to on-site disposal due to poor soil conditions, those households will connect to the drains.

In total, 13 of the 17 currently operational WWTPs receive flow conveyed by CSS. Household connections to these CSS will range from a high percentage of households connected in densely populated areas with poor underlying soils to a much lower percentages in less densely populated areas with easily percolating soils. As mentioned earlier, the exact percentages cannot be determined due to the informal practices associated with the connection itself.

Household connection issues should be well considered in association with the septic tank, the most popular on-site pre-treatment facility in households and other urban buildings. Use of septic tanks for pre-treatment of black wastewater or a combination of black and grey wastewater before household wastewater is connected to the city's combined drainage and sewerage network seems unavoidable in the coming decades. There should be adequate design, construction and management of the septic tank as well as the septic tank sludge. These requirements should be clearly stated in central and local regulations on urban wastewater management.

Household connection to the separate sewer systems. The formal procedures mandated by households connecting to a separate sewerage system, by comparison, ensure that household connections to an SSS are much easier to quantify, control and monitor. In Vietnam, three of the 17 currently operational wastewater systems are based on use of separate sewer systems for collection of wastewater. As mentioned earlier, these include the cities of Da Lat and Buon Ma Thuot, both operational since 2006, and the town of Chau Doc, operational since 2011.

The DANIDA-funded Da Lat and Buon Ma Thuot projects were both formulated on the same principle: the use of separate sewer system networks with household connections. However, the methods used differ significantly between the two projects.

For the city of Da Lat, the narrow streets, limited sidewalks and hilly terrain precluded the use of tertiary sewer pipes for much of the sewerage system, limiting the collection of sewerage to secondary sewers routed in the public roadways. Furthermore, the favored household construction is the bungalow: stand-alone structures, often having septic tanks external to the house itself in the garden area. For these reasons, the strategy for making household connections in Da Lat did not require abandonment of the septic tank, but instead incorporated it into the overall wastewater scheme. This was a decision made to avoid the more complicated procedures that can result from having to physically reroute the sanitary piping within the house itself.

The effluent from the septic tank was conveyed, through the external junction box, to the public SSS. Although this decision to retain the septic tank required that each household continue to maintain their on-site systems, it did reduce the amount of potential deposition of solids in the SSS by providing pre-sedimentation of solids in the septic tank. At present, 75 percent of the potential 6,000 household connections originally proposed have been completed, generating a daily sewage flow of 6,000m^3/day. As a result of the strong information, education and communication program undertaken during project implementation, the community has willingly received the household connection process and now enjoys the benefits from having a public piped sewer system.

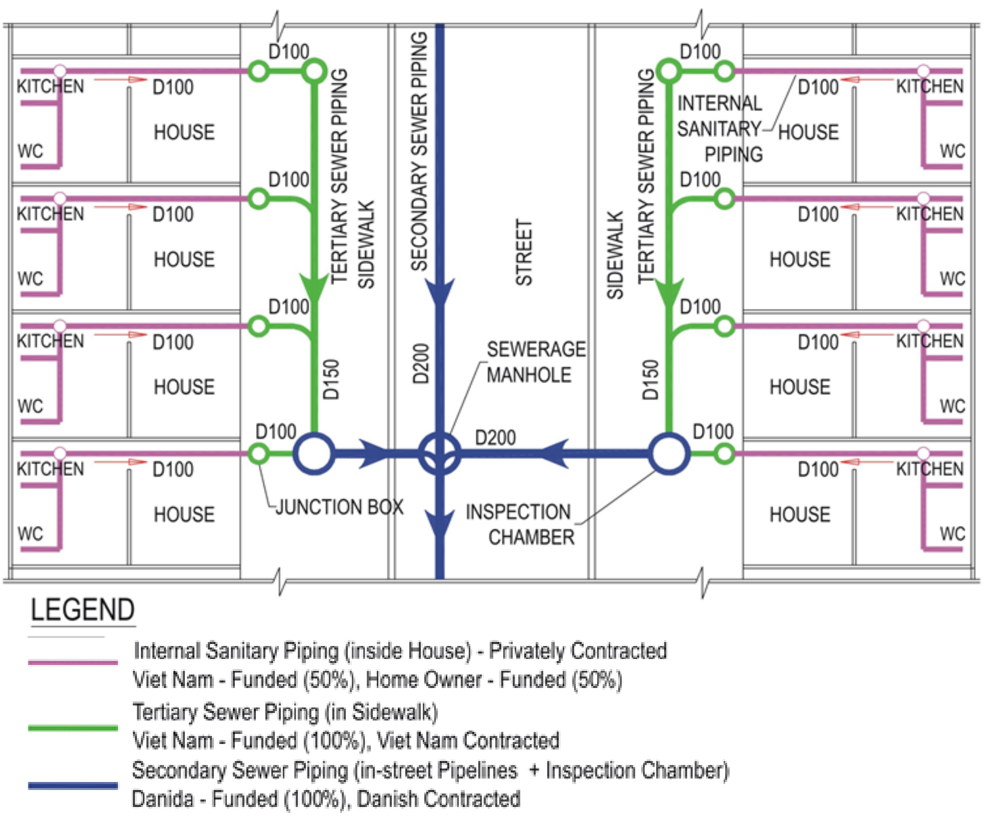
During the site visit by the Review team to Da Lat, it was learned that certain SSS catchments in the city surcharge during rain events. This surcharging resulted in manhole covers lifting to relieve the pressurized flows. As separate systems should not operate any differently in dry or wet weather, since there should be no entry of rainwater, this anomaly in Da Lat was a concern. The Review team surmises that a number of roof drains have been included with some of the household connections, resulting in rapid inflow of rain water to the SSS, causing the surcharged conditions. While the Wastewater Enterprise responsible for operating and maintaining the system actively seeks to remove all such inflow problems, the inflows persist as it is difficult to find all inflow locations. The City has taken remedial action to reduce the effect of this problem by fabricating special pressurized manhole covers containing relief pop-ups, such that the high pressures can be relieved, while minimizing any local flooding. This situation in Da Lat highlights a specific problem regarding the installation of household connections to the SSS, in that inflow to the system must be carefully controlled.

For the case of Buon Ma Thuot, the household construction type is primarily common walled blocks, featuring kitchen/toilets in the rear and SSS in the front utilizing large sidewalk areas and ample street width thereby allowing for the use of a different method for household connection to the SSS. The decision during the design stage was made to completely bypass (or remove entirely) the septic tank at each connected household, linking the collected sanitary flows directly to the tertiary sewers via the junction box located in front of the house. While this action required that much of the sanitary piping beneath the floor of the house be exposed for inspection and re-routing, the end result was that the connected household would never again have to maintain a septic tank, nor be concerned regarding the disposal of wastewater from the premises.

In Buon Ma Thuot City, a total of 4700 household connections have been made thus far, representing 85 percent of the potential household connections envisioned in the design stage. The remaining 15 percent of households have not been connected due to topographic constraints making connection uneconomical or requiring pumping, as well as due to household disagreement over the need to be connected. Some affluent households refuse to connect as they do not wish to accept the disruption caused by the connection itself.

The Buon Ma Thuot City sewerage piping network was conceived on the basis of the use of primary, secondary and tertiary sewerage pipelines to collect and transport sewage flow from the households to the WWTP. Figure C1 (below) illustrates the design relationship and user interface between the sewerage piping systems.

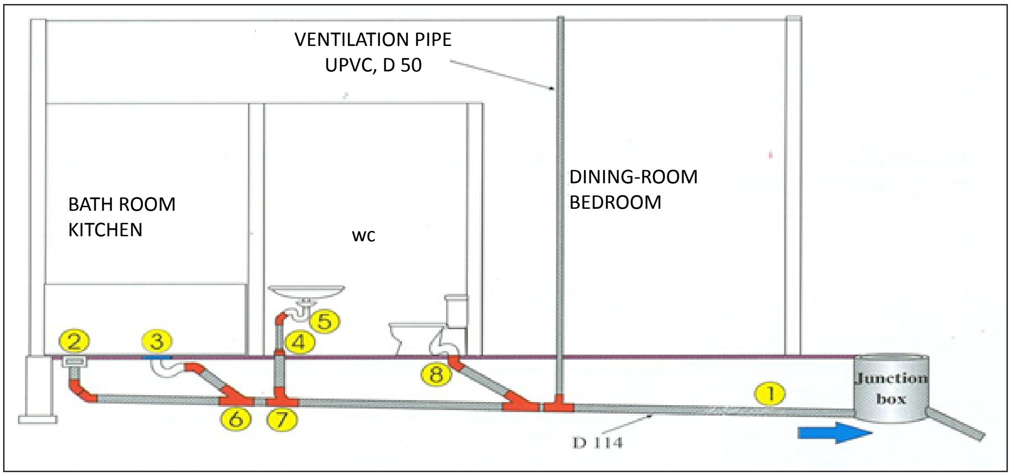
Figure C1: Sewerage Piping System



Source: Corning J, 2009

Procedurally, the house connection process in Buon Ma Thuot was carried out well, with high efficiency and effectiveness. A separate house connection team was established within the project management unit (PMU), which provided training to households and contractors alike in terms of how to properly install a household connection. This team also issued permits to each household applying for connection and monitored the work performed, ensuring that it met a common standard of quality. Most important was verifying that a proper slope was maintained in the conveyance pipeline, venting of the in-house system to the roof was installed, all sanitary fixtures were trapped so as to avoid odors, and most importantly, that no roof drains were connected to the household connection (Figure C2).

Figure C2: Household Connection



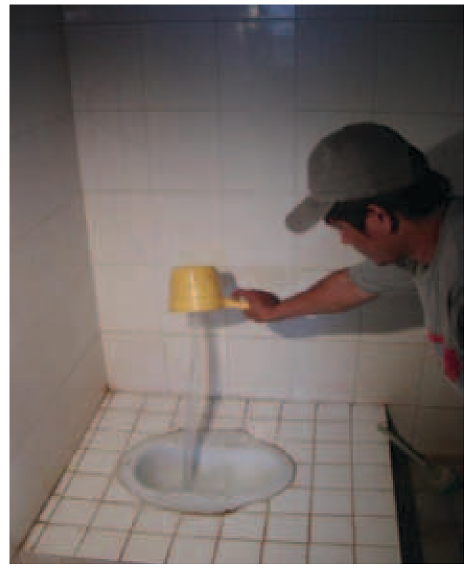
Source: Corning J, 2009

In practice, most household connections were completed within a 2-3 day period, depending on the complexity of the connection. A cash subsidy amounting to 50 percent of the estimated cost of the household connection was provided to each residential household, with the exception of those households with Department of Labor, Invalid and Social Affairs [DOLISA] certification, who received a 90 percent subsidy. Commercial and institutional customers received no subsidy.

Buon Ma Thuot experienced some problems with inflow connections during the early stages of the household connection process. This was due to a misunderstanding with respect to exclusion of the household roof drains from the connection. This problem was discovered and resolved, removing the errant inflow connections. However, during the recent Review team visit, it was learned that a similar problem is being experienced in the catchment tributary to the Tan Tien Pump Station, as that station experiences high inflow during rain events, which quickly diminishes when the rain has ended. The Project Management Unit is already investigating this matter and have taken action to locate and remove the errant inflow connections. Figure C3 illustrates examples of internal house connection works conducted in Buon Ma Thuot project.

Figure C3: Some Photos of Internal House Connection Works

Pipe Laying



Testing Work

Source: Corning J. and BMT UMESC, 2009

4. Conclusions and Recommendations

Household connections are fundamental to the operation of all sewerage collection systems, yet this aspect is often misunderstood in terms of priority of implementation and application. The effectiveness of many combined sewerage systems currently operated in Vietnam is limited by lack of household connections within the system, resulting in weak concentration of influent flow to the WWTP. Such weak influent conditions result in underutilization of WWTPs designed to treat more concentrated wastewater. In most large cities in Vietnam, as well as provincial cities and towns, household connections are carried out on an informal basis, mandated more by need of the household to solve an on-site sewage disposal problem than by government regulation. Such informal connections are often poorly constructed, improperly connected to the drains and lacking of any means for inspection or maintenance, to ensure sustainable operation.

Institutional Framework

Improvement to both the quantity and quality of household connections to piped sewerage systems, whether CSS or SSS, is needed to create the most effective use of public wastewater infrastructure. Such improvement starts with having enforceable regulations in place, which mandate that all households, commercial establishments and institutions within a constructed sewerage collection network be connected to the system. Furthermore, the implementation of these household connections must be regulated by permit and monitored during construction to ensure that a sustainable level of quality is provided. The earlier presented model for house connection policy in Buon Ma Thuot (BMT) may offer some positive ideas in terms of policy, as this program has proven quite effective in implementing a high percentage of connections to the SSS in BMT.

Social Awareness

Public awareness of the need for households to connect to a public sewerage system is also an important factor with regard to improvement in implementation. A well planned and executed IEC campaign, conducted over the duration of a project's implementation and beyond, can create heightened awareness of sanitation issues in the resident population. This has proven to be the case for the projects in both Da Lat and Buon Ma Thuot, communities in which a strong IEC campaign over the five year length of the project and beyond has created very positive community support for the sanitation program and for connecting households to the sewerage system. As related to the Review team by the BMT authorities, this awareness remains strong even six years after the project has ended, with area residents in new City areas eagerly awaiting the opportunity to connect to the piped sewerage system once it has been expanded in coverage in the planned Phase 2 project.

Financial Support

Financial commitment from local government for the implementation of household connections has played an important role in the success of the projects in both Buon Ma Thuot and Da Lat during the Phase 1 works. Such financial support, in the form of a 50 percent subsidy against the cost of the work, was useful in deflecting criticism of the project in terms of impact to the poorer households. Moreover, as the BMT project required significant modification of sanitary piping within the household itself, such financial incentives were considered necessary to ensure community participation. For the Phase 2 works, the authorities intend to continue with some level of financial subsidy to ensure continued success of the program. For cities in which household connection to a CSS network is required, the same principle could be employed to create positive community support for the program, especially in cases in which the household currently discharges to an on-site disposal site, such as soak-away, located beneath the house floor. In these cases, rerouting of sanitary piping inside the household will be needed, potentially creating financial hardship for the household involved.

Technical Assistance

As part of the IEC campaign, the public should be made aware of the more technical aspects regarding household connections, such that they can make informed decisions in terms of how the connection is implemented. Most residents would hire local contractors to carry out the work or carry out the work themselves if they felt capable of doing so. Technical knowledge – such as understanding the basic aspects of pipe sizes and type, slope of pipes laid, access for maintenance and clearing, venting of gases, water trapping of sanitary fixtures and, in the case of connections to SSS networks, the exclusion of all non-sanitary drains is important in the successful installation of the household connection. Brochures, instruction videos (also broadcasts on public TV), billboards, 3D models and small group discussions in focus neighborhoods, all are effective media tools utilized by IEC campaigns to enhance awareness of technical issues.

CASE STUDY 4: SEPTIC TANK AND SLUDGE MANAGEMENT

1. Urban Sanitation Background

Septic tanks were introduced as an on-site wastewater treatment facility in Vietnamese residential areas at the end of 19th century when the French colonists came to Vietnam. (*Nguyen V. A., 2007*). Easily accepted for its simplicity and reliability, the septic tank has enjoyed widespread use and forms the foundation of Vietnam's urban sanitation infrastructure. Over 77 percent of households in cities and provincial towns, 40 percent in district towns and 19 percent in rural areas use septic tanks (*WHO/UNICEF, 2008, and ADB, 2006*).

The Vietnamese regulations allow households to connect directly to the sewer, thus avoiding septic tanks in locations where separate sewerage collection and centralized or cluster wastewater treatment plants have been built. This relates mostly to the new development areas in the cities. In existing urban areas, most of wastewater is directly discharged to combined drains and canals connected to the water bodies. Therefore, the septic tank still plays an important pre-treatment role for locations having combined sewer systems.

2. Septic Tank Design

The National Design Standard of Vietnam for Wastewater Systems, which applies mainly to urban areas, sets the technical specifications and standards for the size and design of septic tanks. The Ministry of Health has issued a manual for septic tank design, installation and O&M. The Ministry of Construction is also drafting the Design Code for the septic tank design and construction.

Septic tanks in Vietnamese cities are often made from bricks for individual houses or from reinforced concrete for both individual houses and public buildings. Septic tanks often are sealed with a concrete base and cement mortar. A tank typically consists of two or three chambers. The first, a receiving chamber, has the largest percentage of the overall tank volume, allowing storage volume for solids accumulation and anaerobic digestion. The total volume of the household septic tank, depending on available space and financial availability, ranges from 1.5 to 5 m^3.

Most septic tanks in Vietnamese urban households receive only black wastewater. Grey wastewater from kitchen, bathroom and washing sinks is generally discharged directly to the city's sewer, avoiding the septic tank.

Due to poor maintenance practices, a post treatment chamber filled with media is not generally used, since household owners are afraid of filter clogging. Septage sludge from most septic tanks is not emptied regularly. There is no enforcement or control by the local authorities for this activity.

The removal efficiency of septic tank ranges from 0 to 50 percent for BOD and SS depending on the septic tank design, type of water flush, de-sludging condition, etc. (*Nguyen V. A., 2007, Harada et al, 2012*). Since many cities still cannot afford to build centralized wastewater treatment plants, such household septic tanks play a very important pre-treatment role.

3. Septage Collection and Treatment

Households pay service providers to empty septic tanks when they are full, which can take from one to ten years. A mix of state-owned, limited liability companies and private companies provide de-sludging.

Due to a lack of treatment infrastructure, service providers usually dispose of septage inappropriately and illegally in drains, fish farms, and waterways.

There are not yet national laws governing the collection and treatment of septage. All de-sludging operators in urban areas are only required to obtain a business license to open and run the business. The national government has not mandated septage management or provided policy guidance. As a result, local governments have no incentive to promote septage management, invest limited resources in operating treatment facilities or support such projects once ODA project funding ends (AECOM & SANDEC, 2010).

Since septage collection companies often also collect solid waste, they commonly dispose of septage at landfills, although solid waste laws also do not address septage. The Ministry of Health is currently drafting guidelines for composting human excreta into reusable fertilizer, based on the World Health Organization's 2006 "Volume 4: Excreta and Grey Water Use in Agriculture" or the "Guidelines for the Safe Use of Wastewater, Excreta, and Grey Water." This initiative indicates that people widely apply untreated septage as a fertilizer and that there is a future for the sustainable, and potentially profitable, reuse of treated septage (AECOM & SANDEC, 2010).

Vietnam's laws specify, but do not yet regulate, septage collection, treatment or disposal. Septage in Vietnam remains a largely uncontrolled pollutant. This problem will likely worsen as urbanization continues and new housing developments install septic tanks as the most popular and well-accepted method of pre-treatment.

There are different types of fecal sludge treatment and disposal as follows:

- Public enterprises:
  - Co-composting with organic waste and selling the product;
  - Co-treatment with wastewater at a centralized sewage treatment plant;
  - Co-treatment with sewage sludge at a centralized treatment plant;
  - Dewatering at sludge thickening facilities, drying beds, selling or dumping; and
  - Dumping at the city's sanitary landfills.
- Private enterprises:
  - Co-composting with organic waste and selling;
  - Illegal dumping to land, city sewers, canals and water bodies;
  - Selling of raw sludge to farm owners (for fertilizer, fish feeding, etc);
  - Dumping to a centralized sewage treatment plant for co-treatment with wastewater or sewage sludge; and
  - Dumping to the city landfills.

Typical models of FSM and key information of FS operators in six surveyed cities of Hanoi, HCMC, Hai Phong, Da Nang, Buon Ma Thuot and Da Lat are presented in Table C5.

Table C5: FSM Models in Selected Cities in Vietnam

Location	Type of Facility/Treatment process	Status
Hanoi	Cau Dzien waste treatment station (mostly for solid waste treatment, upgraded by Spanish project since 2003). For septage: two treatment options were designed: (1) co-composting with organic waste from market; and (2) anaerobic digestion/settling	10 – 30m^3/day (mostly septage from public toilets serviced by Hanoi URENCO) is treated out of 500m^3/day generated. Treatment option (1) does not work. Treatment (2) has limited efficiency. Settled sludge is dumped. Septage collected by private emptiers is discharged illegally to drains or environment
Hai Phong	Trang Cat sludge treatment station (16ha, design capacity 120,000m^3 sludge/yr) built from WB project 1B (operated since 2004) to treat septage and dredged sludge from sewers and drains. Treatment process: sludge drying bed – composting (with mechanical mixing) – sieving – additives mixing – packaging for sale. Leachate is treated in waste stabilization ponds. Residues are dumped at the landfill.	30 – 50m^3/day by Hai Phong Sewerage and Drainage Company including scheduled household septic tank emptying (paid by city budget, started from WB project 1B and still being carried out) and service septage (paid by customers). Treated/composted sludge is kept on site. Low commercial value. Septage collected by private emptiers is discharged illegally to drains or environment.
Da Nang	Khanh Son landfill. Treatment process for Septage: Settling only. Settled sludge is pumped to landfill. Liquid phase is treated in aerated lagoons together with leachate from the landfill.	Current receiving capacity 50m^3 of septage per day. Septage is brought to Khanh Son by both private and URENCO trucks. VND 30,000 – 50,000 per m^3 septage brought. City is currently formulating PSP project on FSM.
Ho Chi Minh city	Dong Thanh landfill. Septage treatment area is 4,000m^2 run by private Fertilizer company Hoa Binh. Treatment process: Sludge storage tank – sludge drying bed /mechanical dewatering – composting – for sale. Liquid phase: treated together with leachate	150m^3 of septage is treated per day. Hoa Binh company is collecting treatment fees from trucks delivering septage, and selling compost to fertilizer making companies. Part of septage collected by private emptiers is discharged illegally to drains or environment
Da Lat	Septage is treated at WWTP. Dried sludge at WWTP, inclusive of septage sludge, is composted and sold for soil amendment.	2 – 3 trucks (5 – 9m^3) per day No treatment fee is charged
Buon Ma Thuot	Septage is treated at WWTP Part of septage is composted at coffee farms	2 – 3 truck loads (5 – 9m^3) per day aretreated at the WWTP. VND 30,000 treatment fee is charged per truck load.

Key stakeholders in FSM

There are two key stakeholders for fecal sludge management in the cities: households and fecal sludge emptying service providers, who can be public or private enterprises. For public enterprises, since FSM is not the primary business of the company, only activities related to the FSM have been analyzed.

Besides households and fecal sludge emptying service providers, there are other stakeholders involved in FSM:

- Government agencies;
- Industries, commercial and public places that use FS emptying service; and
- Fecal sludge re-users.

The role and responsibility for urban public utilities in terms of septage management is clearly stated. However, there is no control on septage emptying, transportation, treatment and disposal service delivered by private enterprises who are conducting business in a purely market-based manner alongside strongly competing public utilities. For that reason, these private enterprises are trying to minimize running costs, which can often lead to the practice of illegal septage dumping. As many of these businesses are unregistered, this effectively limits their access for proper coordination with the public utilities and their access to favorable financing and external technical assistance.

FSM in Hanoi City

The public works enterprise called Hanoi Urban and Environment One member state Company limited (Hanoi URENCO) is responsible for collection, transportation and treatment of domestic, commercial, hospital, industrial and construction wastes in Hanoi city. Additionally, the Company has number of other activities such as: providing of cleaning services for houses and public work places; waste recycling; manufacturing of mechanical products, specialized equipment and mechanical transport vehicles; consultancy, design and construction of civil and industrial works; professional training, technology transfer in urban environment activities; materials and equipment import/ export; doing real estate business, office leasing; labor export. The Company has 14 branch enterprises. Cau Dzien waste treatment is one of its branch enterprises responsible for sludge collection, waste collection and treatment for compost production and land filling of inorganic waste. Fecal sludge de-sludged by the Cau Dzien enterprise is mostly from public toilets in the Hanoi city territory. Solid waste brought into Cau Dzien is mostly from the city markets.

Fecal sludge management is not a major business of the Cau Dzien enterprise. The income from de-sludging services and from sale of compost products does not cover the plant expenses. Hanoi URENCO has to provide a partial subsidy to Cau Dzien.

Figure C4: Vehicle with fake Hanoi HSDC logo illegally dumping fecal sludge to the city sewer

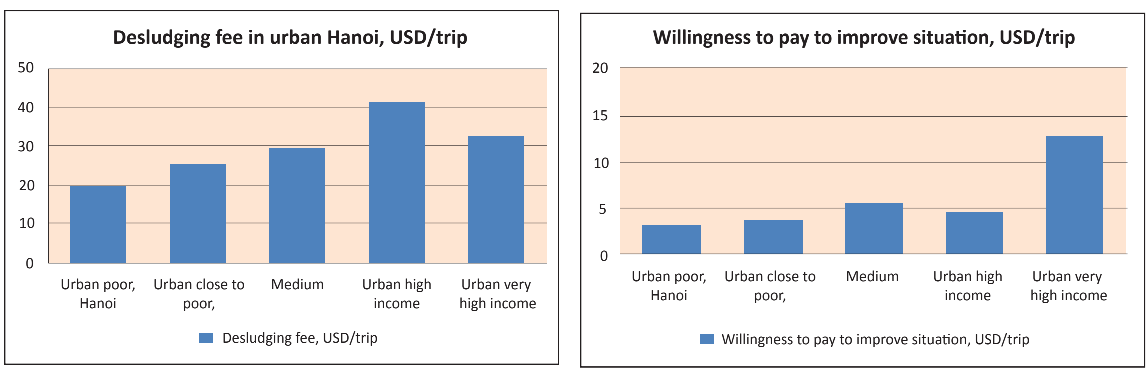
Source: www.vnexpress.net, September 6th, 2011

Private FSM Service Providers: There are 40 private enterprises providing de-sludging services in Hanoi City (Nguyen V. A. et al, 2012). Many continue to illegally dispose of septage (Figure C4).

For most private enterprises providing de-sludging services, this is their major business. Some enterprises generate additional income by utilizing their vehicles for other activities such as emptying and transportation and dumping of industrial waste, construction waste, etc. A number of owners, managers and key staff of the private enterprises previously worked for the Hanoi URENCO or Hanoi Sewerage and Drainage One member state Company limited (SADCO). This demonstrates that de-sludging in Hanoi must be a profitable business as it attracts people from the city's URENCO to leave their work there and to join the private companies.

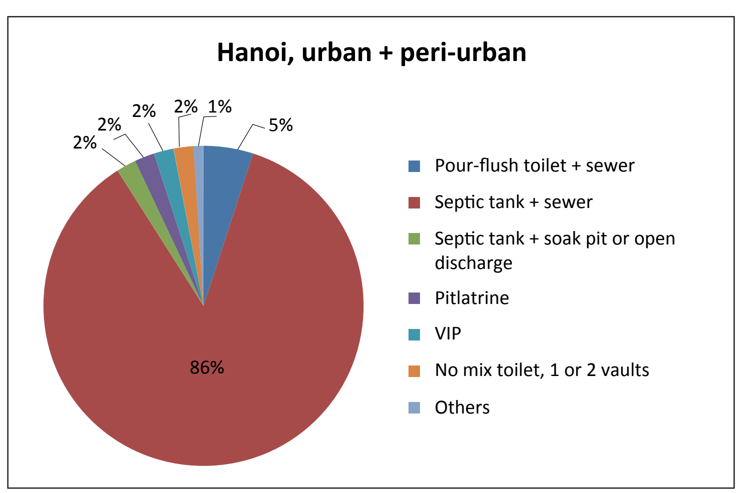
Public Awareness and Willingness to Pay: Expanded media coverage of the environmental police catching de-sludging companies illegally dumping septage and scheduled de-sludging efforts may be increasing public awareness of the need to manage household septic tanks. Considering the current GDP in Hanoi (around USD 1,900 per capita per year), a cost of USD 20 – 40 for de-sludging of a household septic tank could still be a costly expense for many households (see Figure C5). Prevailing low tariff structures and unwillingness to adopt the regular wastewater fee has made it difficult for cities with septage treatment facilities to continue effective operation.

Figure C5: De-sludging fee and willingness to pay in urban Hanoi



Source: Nguyen V. A. et al, 2012

Figure C6: Sanitation types in Hanoi City

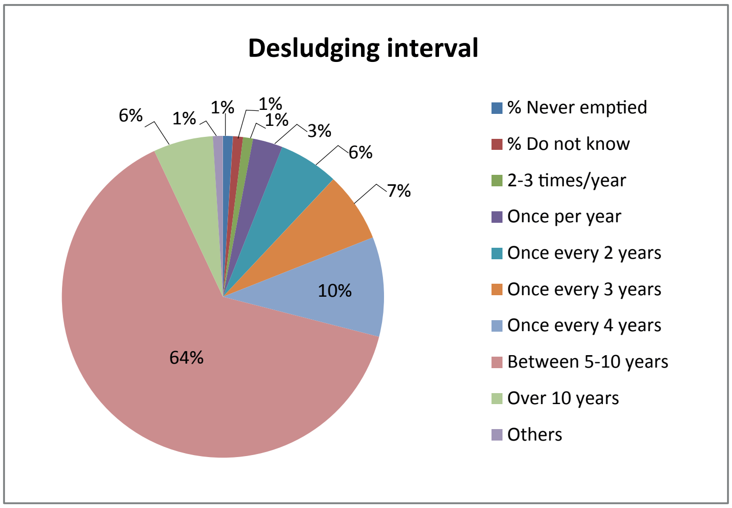


Source: Nguyen V. A. et al, 2012

Figure C6 presents sanitation types at surveyed households in urban and peri-urban areas of Hanoi city. The most popular is a "water closet" type with septic tank (88 percent). The scheme of "septic tank + sewer" comprises 86 percent whereas ''septic tank + soak pit or open discharge'' is only 2 percent. Latrine pit types are around 4 percent and are mainly used in the peri-urban areas (10 percent of peri-urban households). There are 8 percent of the population not using a fecal sludge emptying service including 5 percent of households with direct sewer connections (without septic tank), 2 percent with no mix toilet and 1 percent without any toilet facilities.

The average latrine pit volume in Hanoi is 1.3 m^3; the average cesspool holding tank volume in Hanoi is 1.8 m3 (data gathered from the field survey, Nguyen V. A. et al, 2012). High groundwater table and limited space in dense population areas are the main reasons for the small size of pit latrines in the Hanoi area. Users must de-sludge these small pits frequently. Some of them reuse emptied sludge from pit latrines after co-composting with agricultural waste for few months. Most of the households do not care to where their fecal sludge will be transported and dumped or treated. Awareness raising activities in FSM require improvement in the near future.

Figure C7: Frequency of Fecal Sludge Emptying in Hanoi



Source: Nguyen V. A. et al, 2012

Figure C7 illustrates that the emptying frequency of once in 5 - 10 years predominates in 64 percent of the total surveyed households. About 1 percent of households emptied twice a year. Those septic tanks are probably very small and are overloaded. *The average de-sludging interval of septic tanks in Hanoi is 6.2 years*.

Fecal sludge collected by the Cau Dzien enterprise (or Hanoi URENCO 7) is mostly from public toilets. Solid waste brought into Cau Dzien is mostly from the city markets. The plant was built in 1992 and upgraded in 2002 through an ODA loan from Spain. The design capacity of Cau Dzien composting plant is 13,600 tons/year. Fecal sludge is an additional material which is co-composted with separated market organic waste for the composting process. Theoretically, the addition of fecal sludge into the composting pile at an appropriate sludge/organic waste ratio provides a more favorable environment of C:N ratio and moisture for the composting process, creating a better quality of the composted product. The current capacity of the plant is around 5,000 tons of compost per year.

Currently, actual fecal sludge receiving capacity of Cau Dzien is only from 20 to 50 tons/day due to limitation of treatment and marketing capacities. That amount is still far from the estimated city's need or market where the actual amount of fecal sludge emptied daily is around 189 tons/day (*Nguyen V. A. et al, 2012*).

FSM in Hai Phong city

The number of septic tanks in Hai Phong city is about 221,000 (88 percent). Pit latrines number about 25,100 (10 percent). About 2 percent of Hai Phong citizens have no toilet facilities. The number of septic tanks has increased rapidly over the past years, especially after the 1B project whereby low-income families could have access to the Revolving Fund operated by the local Women's Union for household toilet upgrading and sewer connections. In other cases, the city population is shifting to utilization of septic tanks, especially when the house has been upgraded or is newly built.

As part of a commitment signed between the Vietnamese Government and the World Bank within the 1B project, Hai Phong city has had to collect a wastewater fee of 15 percent surcharge added to the water bill and to increase that fee gradually. From 2005, the Hai Phong SADCO started to collect that wastewater fee. Until now, all other cities in Vietnam, except Hai Phong and Soc Trang, are collecting a wastewater fee of 10 percent surcharge on the water bill.

The public works enterprise called Hai Phong Sewerage and Drainage One member state Company limited (Hai Phong SADCO) is responsible for O&M, rehabilitation, construction of sewerage and drainage, wastewater and sludge treatment systems in Hai Phong city and surrounding areas. In addition, the Company has a number of other activities such as design and construction of civil and industrial works. The Company has seven branch enterprises covering the whole territory of the city. Trang Cat sludge treatment is one of its branch enterprises responsible for treatment of sludge collected from septic tanks, drainage and the sewerage system.

Septage sourced from the de-sludging of septic tanks was designed to be transported to a site located adjacent to the existing sanitary landfill. The septage will be mixed 1:1 with biodegradable waste sorted from the municipal waste and left to compost for two months. During that period, the compost will be mixed frequently to increase aeration. Afterwards, the composted sludge will be transferred to a maturing area for four months. From there, it will be transferred to the sanitary landfill for use as cover and final reinstatement material.

Fecal sludge management is not a major business of Hai Phong SADCO. The income from de-sludging services does not cover the expenses. Hai Phong SADCO has to provide a cross-subsidy for this FSM activity through part of the collected wastewater fee.

Based on the approved plan of activities of the sewerage and drainage system O&M prepared by the City's authority, the Hai Phong SADCO is paid from the annual city budget. Approximately 15 percent of the budget is paid for the scheduled de-sludging of septic tanks from households, communal houses or living quarters and public toilets in the city. The amount of collected wastewater fee is increasing annually and has become sufficient to cover sewerage and drainage O&M and scheduled septic tank de-sludging expenses since 2010.

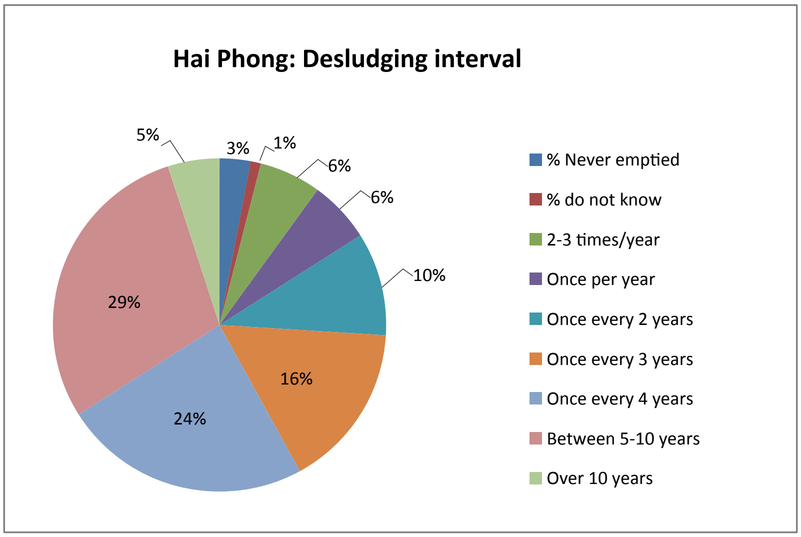
The Company is planning to ask the city's authority to increase the wastewater fee percentage from 15 to 20 percent surcharge of the water bill in 2012, 25 percent in 2015, and 40 percent in the later stages.

In the HP SADCO's GIS database there are 86,501 septic tanks under scheduled de-sludging located in four urban districts. HP SADCO is planning a de-sludging interval for household septic tanks once every five to six years and for the communal houses (living apartments) once every one to two years. HP SADCO has provided free-of-charge scheduled de-sludging of 80,270m^3 of fecal sludge from 44,682 septic tanks spread over 40 to 47 wards and living quarters in four urban districts (Hai Phong SADCO, 2012).

Hai Phong SADCO is also operating Trang Cat sludge treatment complex built from the WB 1B project. The total area of Trang Cat is 162,844 m^2, design capacity is 120,000m^3/yr for receiving and treatment of both sludge dredged from sewers, canals and lakes and fecal sludge from septic tanks.

For the private enterprises, de-sludging service is their major business. Some of enterprises have additional income utilizing purchased trucks for other activities such as emptying and transportation and dumping of industrial waste, construction waste, etc. A number of owners, managers and key staff of the private enterprises previously worked for the Hai Phong URENCO or SADCO before they left and invested in this business. Since a large part of the FSM market in Hai Phong is owned by the Hai Phong SADCO, private enterprises are trying to minimize running expenses, offer additional services such as hazardous waste collection and disposal and desludging of septic tanks from industrial sites. The enterprises are also expanding their working place to the surrounding areas where sludge can be emptied and resold to fish ponds or agricultural farms.

Figure C8: Frequency of Fecal Sludge Emptying in Hai Phong City



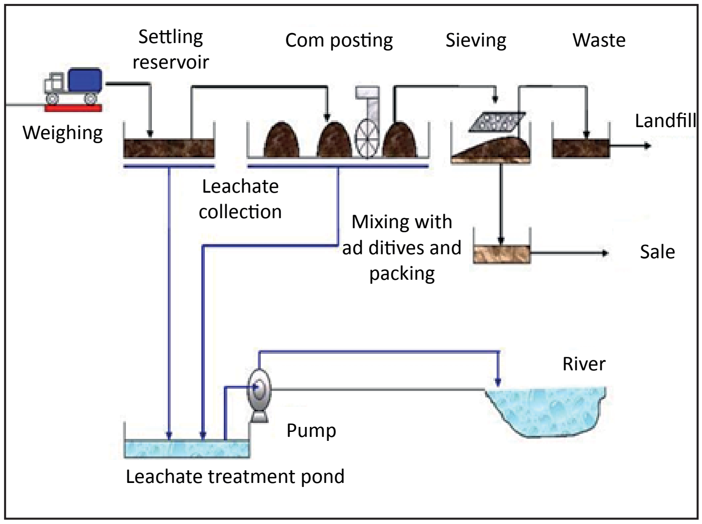
Source: Nguyen V. A. et al, 2012

Figure C8 shows that the emptying frequency in Hai Phong of once every 5 - 10 years applies to only 29 percent of the total surveyed households. About 6 percent of households emptied twice a year. *The average desludging interval of septic tanks in Hai Phong is 4.4 years.*

Mechanical emptying is applied in most cases in Hai Phong. The Company has been equipped with 16 vehicles from the 1B project with tank volumes ranging from 0.5 m^3 to 7.75 m^3. In order to reach households in narrow and long alleys in the city, the project uses three small (0.35 m^3) tankers equipped with a small pump and storage volume. The tankers can be mounted behind a special truck or rolled manually. This small vacu-tug collects sludge from the households in the alley and discharges to an intermediate tanker of 10m^3 volume waiting on the main street.

Trang Cat treatment area is 5 ha, including three composting lines for sludge and organic wastes, a 0.4 ha settling pond, a 1 ha sludge drying bed, a 0.6 ha receiving pond and 1.2 ha of treatment ponds. The plant is equipped with modern tools such as crane, mixing and turn over machines, sieving machines, pumps, etc. (see Figures C9 and C10)

Figure C9: Process Line of FS Treatment in Trang Cat Plant



Source: Hai Phong SADCO, 2012

Figure C10: Settling Pond for FS Treatment in Trang Cat

Photo by Nguyen V. A., 2012

The amount of sludge brought to Trang Cat ranges from 10,000 to 25,000m^3 per year. The projected sludge to be treated at the plant will be increased when the Environmental Sanitation project (2011 – 2015, JICA fund) is implemented..

FSM in Ho Chi Minh City

There are four types of enterprises dealing with FSM service in Ho Chi Minh City, as follows:

1. The public utility Ho Chi Minh city's Environment One member state Company limited (HCMC CITENCO);

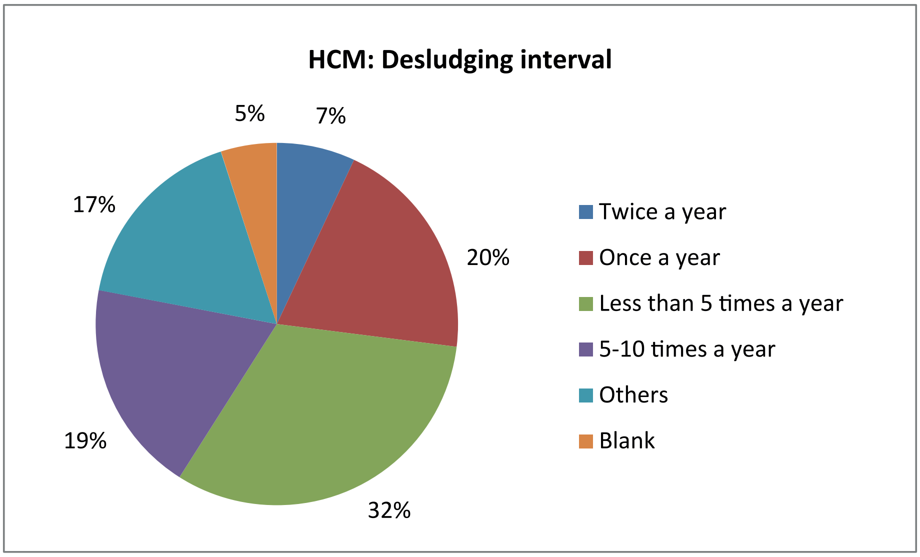
2. Private enterprises having only a FSM emptying and transportation business;
3. Private enterprises having FSM as one of different activities; and
4. FS treatment and fertilizer production companies.

The public work enterprise HCMC CITENCO is responsible for collection, transportation and treatment of domestic, commercial, hospital, industrial and construction wastes in Ho Chi Minh city. The Company has a number of other activities such as: provision of cleaning services for houses and public work places; waste recycling; manufacturing of mechanical products, specialized equipment and mechanical transport vehicles; consultancy, design and construction of civil and industrial works; professional training, technology transfer in urban environment activities; materials and equipment import/ export; real estate, office leasing; labor export.

The Company has five branch enterprises dealing with different activities. Sludge emptying from public toilets is only a small part of the activities of the company. Diverse activities of the CITENCO urban environment company include installation of a water supply system, solid waste collection, transportation and delivery of goods by truck, repair and construction of septic tanks , hazardous waste transportation, bonsai and green spaces care, sales and lease of sanitary equipment (such as mobile public toilets), civil and industrial construction, transportation and irrigation, etc. Related to fecal sludge (FS) management, CITENCO empties most public toilets, including fixed and mobile ones, and leases mobile public toilets. The Company has seven trucks with an average tank volume of 5.5 m^3. Urban customers often prefer to use services from state enterprise companies which generally have more capacity and credibility.

Out of five surveyed private enterprises, there are two enterprises dealing with FS emptying service only. The other companies perform other activities such as installation of drainage systems, domestic, commercial and industrial solid waste collection, hazardous waste collection, water and wastewater treatment, construction and repair of septic tanks, sewer dredging, etc. Some are utilizing purchased FS trucks for emptying and transportation and dumping of commercial, industrial and construction waste, etc.

Figure C11: Frequency of Fecal Sludge Emptying in Ho Chi Minh City



Source: Nguyen V. A. et al, 2012

C11 illustrates that 52 percent of the total surveyed septic tanks are emptied once every one to five years. About 7 percent are emptied twice a year. This indicates that there is a portion of septic tanks built not following the construction standards in HCMC. Furthermore, people only call the emptiers when the tank is full or is generating bad odors, etc. Most people whose tanks are emptied infrequently have limited knowledge of the details of their septic tanks, providing incomplete answers to the questions such as tank dimensions, emptying frequency, tank performance and upgrading the septic tank.

Dong Thanh landfill has been designated by HCM City People's Committee to receive and treat the fecal sludge with an average capacity of $180m^3$/day and having a treatment area of about $4000m^2$.There are two types of products produced: dried sludge, which will be sold to households in the area as fertilizer at a price of around VND 600,000/ton (USD 30/ton), and bio-sludge, which is sold to the wastewater treatment company for VND 800,000/ton (USD 40/ton).

FSM in Da Nang City

In addition to Da Nang URENCO, there seven to eight private enterprises providing FSM in the City. In total, 30 – 40 trucks are operated in the whole city providing emptying services ranging from of 10,000 – 20,000 tons of FS per year.

Simple technology is currently used to dewater sludge brought by all public and private trucks into Khanh Son landfill. The private emptier pays VND 25,000 for 1 m^3 of FS brought into Khanh Son landfill. A monthly fee basis is also applied (VND 3 – 5 million per truck per month) for frequent emptying.

Unlike Hai Phong City, a scheduled FS emptying program established under the WB project 1B has been discontinued in Da Nang since 2009. Explanations offered for this dis-continuation of service was that the program was only a pilot-scale, city budget was limited, and control on household connections and household septic tank operation was poor.

A four-hectare site has been reserved at the Khanh Son landfill for a new FSM project, where City wants to invite the private sector to take part. A comprehensive sludge management strategy is needed for Da Nang City.

FSM in Buon Ma Thuot and Da Lat Cities

Buon Ma Thuot and Da Lat are two cities where the use of a separate sewerage system was first introduced in Vietnam (in operation since 2006). However, the DANIDA projects could fund only 30 – 40 percent coverage of the city area. The remaining coverage is still based on septic tanks connected to combined drains or soak pits. With loading rates of 2 – 3 trucks per day, FS is transported by private emptiers to the centralized wastewater treatment plants and co-treated with wastewater (Figure C12 and Figure C13).

Figure C12: Fecal Sludge is Discharged to Receiving Chamber of Da Lat WWTP

Photo by Nguyen V. A., 2012

The Da Lat WWTP operator now makes compost from dewatered sewage sludge, inclusive of septage sludge, for selling to flower and vegetable farms in Da Lat City.

Being aware of the rich nutrient and organic value of septage waste, some emptiers are supplying septage waste to farmers for direct or indirect use in agriculture or aquaculture. Some private enterprises are co-composting septage with agricultural wastes and organic wastes for making compost fertilizer. No clear strategy on quality control, including safe reuse, of septage-generated compost products has been established, except Decision 04/2007-QD of MARD, which bans the utilization of fertilizer made from human and animal waste for vegetables.

FSM in Ha Long city and Bai Chay ward, Quang Ninh province

The World Bank project in Quang Ninh provided two centralized wastewater treatment plants for the Ha Long and Bai Chay areas in Quang Ninh provinces. Both components included activities such as household septic tank improvement and sewerage network connections through a revolving fund, capacity building for the urban environmental company and construction of a FS receiving and treatment station at centralized wastewater treatment plants in Ha Long and Bai Chay. The selected treatment technology was lime conditioning and dewatering at covered sludge drying beds. Both FS treatment stations are no longer operated as the FS emptying program has been discontinued (Figure C14).

Comparison with solid waste management service models in 3 largest cities

Hanoi: de-sludging of household and office septic tanks is by private enterprises; public toilet de-sludging is by State one member Company limited Hanoi URENCO's enterprise No. 7. URENCO 7 is producing compost from fecal sludge and organic waste and selling the compost product. URENCO 7 gets a cross-subsidy from the Hanoi URENCO, which has major income from solid waste collection and other services.

Hai Phong city: scheduled de-sludging of HH septic tanks is done by State one member Company limited Hai Phong SADCO for free; other HH and office septic tank de-sludging is done by HP SADCO and by private enterprises for a fee; public toilet de-sludging is by HP SADCO. HP SADCO is allowed to use part of the collected wastewater fee for scheduled de-sludging. The City provides a partial subsidy since the 15 percent surcharge from the water bill for the wastewater fee is not enough to cover the O&M expenses of the enterprise.

Figure C13: Septage Pumper Truck Off-loading to Septage Receiving Station at WWTP (Buon Ma Thuot City)

Photo by Nguyen V. A., 2012

Figure C14: Sludge drying bed with non-functioning FS receiving building in the background

Photo by Nguyen V. A., 2012

Ho Chi Minh city: de-sludging of HH and office septic tanks is by private enterprises; public toilet leasing and de-sludging is by HCMC State one member Company limited CITENCO; fecal sludge treatment is done by another private company which is collecting a fee for each delivered m^3 of sludge and selling the composted product. FSM business is regulated mostly by the market.

Opportunities for improvement

In Hai Phong, FSM is a part of the urban drainage and sewerage system management, whereas in two other cities, Hanoi and Ho Chi Minh, the solid waste management company is taking over FSM operations. Improvement of the FSM situation in the cities can be realized through the following options:

a. Consideration of FSM as a part of the drainage and sewerage system. FSM can be operated under the "polluter's pay principle'' through increase of the wastewater fee (Hai Phong model);
b. continuing to leave FSM to the private sector while the city enhances control and inspection and at the same time, provides financial incentive measures for FS emptiers to bring sludge to the approved dumping or treatment sites (Hanoi model);
c. Increase in the de-sludging fee paid by the household owners as an alternative to option (2) to reach recoverable levels for the emptiers. Strict control on FSM will avoid illegal dumping.
d. Apply an integrated waste management model in the city. Waste flows are treated or co-treated for recovery of resources, for example, biogas, fertilizer, wastewater reclamation, etc. Integration of sustainable waste management concepts should be incorporated into long-term urban planning.

4. Role of Public Sector in Business Sustainability

Currently, the business of the FSM private enterprises does not cross-cut any public activity. Their own marketing, de-sludging and illegal dumping of emptied sludge does not receive any support from the city authorities.

Hanoi has been conducting the 3R (reduction, reuse, recycle) project since 2006, with at source separation of solid waste campaigns and capacity building activities for the Hanoi URENCO. The project is funded by the Japanese and technically supported by JICA. Separated organic waste from four pilot wards in Hanoi urban area is transported to the Cau Dzien composting plant for making compost fertilizer. Fecal sludge brought to Cau Dzien is also being co-composted. Expansion of the 3R project and implementation of an appropriate marketing strategy for the compost product may improve the business situation for the Cau Dzien composting plant, which should receive emptied sludge from the toilets. Furthermore, the capacity of the composting plant should be increased. Hanoi is currently considering investing in a new module for the fecal sludge treatment station in Cau Dzien.

Awareness raising for frequent de-sludging of household and public septic tanks can be made with efforts not only of private service providers, but also by public sector stakeholders such as public utilities (Sewerage and Drainage company, Urban Environment company), local authorities at ward, district and city levels, schools and universities, NGOs, etc. Good experience in awareness raising for septic tank emptying have been recognized in some urban environmental sanitation projects such as the World Bank 1B project in Hai Phong (2000 – 2009). With the prevailing high percentage of septic tanks among on-site sanitation facilities in Vietnamese cities, frequent de-sludging of septic tanks will ensure a sustainable market for the de-sludging, transportation, treatment and reuse business, not to mention improved performance of septic tank operations.

Strict control in fecal sludge dumping by the city authorities and the public will also impact on the illegal business practices of the private FSM enterprises. Strong penalties applied to illegal dumping cases will force enterprises to reconsider their sludge transportation and dumping practices. Additional charges for emptied and delivered sludge volumes should be applied in order to keep the private FSM business profitable.

5. FSM Financial Analysis

A recent study on FSM conducted by Bill and Melinda Gates Foundation (*Nguyen V. A. et al, 2012*) has shown all private FSM enterprises are making profits. The average annual profit made by Hanoi private enterprises is USD 2,835/truck, by Hai Phong enterprises: USD 3,187/truck and by Ho Chi Minh enterprises: USD 10,727/truck. The average profit of the HCMC enterprises is much higher than for other cities. The return on investment ranges from 3 – 4 years in Hanoi; 3 years in Hai Phong; and 1 – 4 years in Ho Chi Minh City.

Regarding public utilities in the three surveyed cities, only the Ho Chi Minh Urban Environment Company CITENCO (HCM.01) is making a profit. The main source of revenue and profit for HCM.01 is not coming from de-sludging services, but from leasing public toilet cabins (57 percent vs. 43 percent of revenue). HCM.01 also receives revenue from FS emptying of the rented toilet cabins. Unlike the Hanoi and Hai Phong public utilities, HN.01 and HP.01, the enterprise HCM.01 is not involved in FS treatment and therefore high depreciation costs for the waste treatment plant are not included in the company financial statement. Correlation is also found in the break-even point calculation. For HN.01, 2016 trips were actually made in 2010, while the enterprise should have made at least 9,826 trips, due to the significant annualized depreciation costs of investment capital, in order to make a profit in the FSM business. On average, instead of the current number of trips of 403 per year, each truck should be making 1,965 trips, which may not be possible.

A similar situation is apparent in the case of the Hai Phong public utility HP.01. The enterprise should increase the number of trips per truck per year up to 1,422 instead of the current number of 1008 trips in order to have a profitable business. Those numbers are much more than the break-even point of Hai Phong private enterprises (264 trips per truck per year).

For the Ho Chi Minh City public enterprise HCM.01, as discussed above, there is no issue regarding the need for making large investments such as is found in HN.01 and HP.01. The break-even point of HCM.01 is at the same range as the private emptiers.

6. Conclusions and Recommendations

a. Public enterprise retains a significant market share for FSM in the three largest cities in Vietnam. However, the private sector assumes a larger role in FSM emptying in other cities. For public enterprises, in most cases, the FSM business is not profitable. These companies are running FSM as a public service activity, one which is often cross-subsidized by other activities of the enterprise, or subsidized by the city's budget.

b. FS can be treated together with wastewater or sewage sludge at centralized sewage treatment plants, together with organic waste by composting, or by anaerobic digestion processes. Depending on actual circumstances, in order to ensure efficiency and sustainability, a FS strategy should be developed and incorporated into urban infrastructure planning, including water supply, sewerage and drainage, as well as solid waste management.

c. In the city of Hai Phong, the scheduled fecal sludge emptying service for the community is free of charge. Even with a wastewater fee equivalent to a 15 percent surcharge on the water bill collected and all revenues used to cover the FSM activities of the authorized public utility (Hai Phong SADCO), the business still does not make a profit. The main reasons for this loss are high annualized depreciation costs and the limited number of trips per truck per day, which are much fewer than the break-even point in the financial analysis.

d. All private FSM enterprises are making profits. However, in order to reduce running costs, most of them practice illegal FS dumping which is contributing to serious pollution of the city environment and public health.

e. For emptying and delivery services, de-sludging expenditures, including running and depreciation costs, can be recovered by competitive fees. However, FS treatment expenditure may not be recovered. Critical factors here are the selected technology for FS collection, treatment and reuse, and the accepted market values of the compost product.

f. There are some opportunities for the private FSM enterprises to increase profit, while maintaining proper FS dumping. Those opportunities include: (a) to change the enterprise business model, expanding the scope of activities and income; (b) to enforce regular de-sludging of septic tanks and pits with support from the city authorities; and (c) to increase the desludging fee or for the city to provide a subsidy to cover costs paid for each m^3 of proper delivery of sludge. Increased wastewater and/or solid waste management fees are among appropriate revenue sources to generate the city subsidy.

g. One of solutions for improving FSM service in the city is to give the right to run this business to the local public utility. This service is then controlled by the city, and paid for by the users. In addition to direct payment for each de-sludging service, indirect payment through water bills, as part of wastewater fee, could be realized given that an urban public utility will provide scheduled de-sludging for the users. At the same time, service-based de-sludging is still available in the city by the public or private enterprises.

h. FS market demand is one of deciding factors for the company's revenue and associated benefits. Cost for the FSM service should be high enough to fully cover expenditures.

i. The FSM business should be operated by market driven principles. However, the coordination role of central government and local authorities should be highlighted. If the environmental sanitation regulation framework is weak, and competitive pricing for FSM is low, FSM operators will try to find ways to break the rules to reduce their costs and increase competitiveness, such as careless pumping, illegal dumping and other poor service behavior. In addition to appropriate awareness-raising for the public and FSM enterprises, administrative and public control, there are different financial tools which can be applied.

j. The most sustainable management model for FSM is to apply an integrated waste management concept including centralized or semi-centralized waste collection and treatment systems. Using the same infrastructure for solid waste or wastewater management in the city for the FSM is the most feasible and sustainable solution in Vietnamese cities. The integrated waste management system may include at-source separation of wastes, co-treatment of sludge, organic waste and sewage treatment plant sludge for resource recovery through biogas recovery, wastewater reclamation, digested sludge utilization, etc. Utilization of the same infrastructure helps to economize investment and operational costs significantly where resource recovery brings more benefits. Furthermore, a public–private partnership (PPP) model is a potential option to overcome the challenges faced by the need to invest significant capital.

CASE STUDY 5 - WASTEWATER PLANNING, PROJECT IMPLEMENTATION AND PERFORMANCE

1. Wastewater Planning

The law on Urban Planning (2009) and the Decree 37/2010/ND-CP regulate activities relating to the formulation, assessment and approval of urban planning. Decree 88/2007/ND-CP also describes waste water planning issues relative to drainage and sewerage in urban areas and industrial zones (IZs). There are some inconsistencies found among these legislations, examples of which are listed below.

a. Point 4 of article 12 of Chapter II in Decree 88/2007/ND-CP stipulates development of separate urban drainage and sewerage plans for urban centers of category II and upwards. However, Article 21 of Decree 37/2010/ND-CP requires development of specialized technical infrastructure plans for state-governed cities (U3SAP study report, 8/2012). The details on drainage and sewerage planning stipulated in Decree 88/2007/ND-CP should therefore be adjusted to conform to the Urban Planning Law and to Decree 37/2010/ND-CP.
b. Articles 14 and 16 of Decree 88/2007/ND-CP on the tasks and content of drainage and sewerage plans, covering the different levels of area and regional planning and urban center planning, does not clarify the above inconsistency as the detailed level of planning is different (see U3SAP study report, 8/2012).
c. Article 16 of Decree 37/2010/ND-CP on master planning for provincial cities, point 5 on orientations of urban infrastructure, drainage and sewerage does not seem to be sufficiently comprehensive to develop a sanitation strategy, and to make correct technical selections for drainage and sewerage projects.

Even though orientation for urban drainage and sewerage development is planned through to the year 2025, vision 2050 has been established and stipulated in the Prime Minister Decision No. 1930/QD, where separate sewerage systems should be built in new urban development areas. However, in practice it is difficult to implement this provision due to the increased cost for the installation of the CSS as well the inadequate urban monitoring and management. Recently, the Prime Minister approved the drainage and sewerage plans for three key economic zones including Northern, Central and Southern regions (Decision 1336/QD-TTg dated September 22, 2008) and the drainage plan for the Mekong Delta key economic zone (Decision 2066/QD-TTg dated November 12, 2011). The Ministry of Construction is assigned to manage the plan, provide guidance to provinces to formulate and adjust the drainage and sewerage plans as appropriate and select investors for planned projects. In practice, most cities and towns are eager to develop drainage and sewerage plans to speed up their development. Most of the existing plans focus on expanding and rehabilitating the current combined drainage and sewerage system. Separate sewerage systems are designed for new development areas. However, planned wastewater treatment plants are generally sited beyond the new development area project border. Prior to reaching the WWTP, separate sewerage and drainage are joined and mixed again and the network becomes a combined sewerage system along the roads outside the project area. Sewerage and Drainage Companies as well as local authorities have had poor control with regard to connection of households' discharge pipes to drains or, in some cases, discharge of surface runoff to separate sewers.

The WWTP treatment technology option should be included in the wastewater plan so that the required land for wastewater treatment plants including buffer zones can be reserved. In this way, low-cost technologies can be applied. Greater project efficiency and sustainability would be assured. So far, only some cities have managed to follow this direction.

Buon Ma Thuot could be considered a good lesson for urban wastewater planning. Currently, the project can provide wastewater connections and treatment for 5,500 households. The sewer trunk mains have been designed for 17,000 households from the whole city area. In total, an area of 20 ha has been reserved for the treatment plant site enabling wastewater treatment plant expansion in future phases. Nhieu Loc – Thi Nghe project is also another case. In the 10 years between 2002 and 2012, USD 800 million has been invested for drainage improvement and flood mitigation, wastewater collection and local infrastructure upgrading. A wastewater treatment plant will be constructed only in the second phase although significant improvement in the urban environment from phase one has been recognized by the local residents. In comparison, there are very costly lessons in urban planning and wastewater project phasing in Hanoi, Da Nang, Ha Nam and some other cities. Construction of North Thang Long – Van Tri wastewater treatment plant was completed in 2007 through a loan from the Japanese Bank for International Cooperation [JBIC] with design capacity of 38,000m^3/day. However, until now, wastewater from the surrounding residential areas has not been connected to the plant. The WWTP currently operates at the capacity of 7,000m^3/day treating primarily the processed effluent of a nearby industrial park of Thang Long (Figure C15).

Figure C15: The WWTP in Hanoi city under-utilized due to lack of sewer connections

Photo by Nguyen V. A., 2011

Three of the four existing wastewater treatment plants built in Da Nang will be closed down, with wastewater diverted to two new plants, Hoa Xuan and Lien Chieu, by the year of 2020. The three existing WWTPs to be closed are all located in the fast growing city area and the selected treatment technology does not allow the plants to achieve effluent standards.

Construction of a WWTP in Phu Ly, Ha Nam province was completed several years ago. However, due to incomplete household connections and sewer network components, the WWTP has not yet been put into operation. A similar situation is found in some other cities such as Nui Sam (Chau Doc, An Giang), Vinh (Nghe An). The lack of prioritization for such important wastewater system components as household connection and collection networks to complement investment in WWTPs leads to inefficiency of invested resources. Furthermore, poor household connections and dysfunctional WWTPs disappoint residents who in turn may lose interest in participation in future wastewater project activities.

In general, the implementation of drainage and sewerage plans is slow; activities are focused on mainly improving existing sewerage systems and building new systems to extend urban areas and offer solutions for heavily polluted areas. It is necessary to promote the formulation and approval of sanitation planning as the basis for urban management from central and local levels as well as to formulate and implement investment projects. The formulation, approval and implementation of sanitation planning in the provinces and cities are very slow. The reasons are:

- local authorities have not paid sufficient attention to planning for construction management;

- inconsistency of different development plans, or lack of a guiding urban master plan which sanitation planning should follow or be included as part;
- implementation capacity of the provinces is limited, while budgets to conduct comprehensive surveys and data collection as well as to mobilize competent consultants for sanitation planning are also limited; and
- low quality plans, poor forecasts and non-comprehensive projects have led to difficulties and revisions in plan implementation.

At present, drainage plans have been prepared and approved in ten provinces. The remaining provinces are either revising or preparing to formulate their respective plans. Although not all of the provinces have developed drainage and sewerage plans, some are implementing drainage projects, including some funded by ODA. For example, Phu Yen province has invested in two drainage/sewerage system projects for Tuy Hoa city and Song Cau town under the Central Small and Medium Urban Development Project funded by ADB; Binh Dinh province is implementing the Quy Nhon city environmental sanitation project with significant technical infrastructure including drainage, sewerage collection, wastewater treatment plant construction as well as a solid waste management plant.

Sanitation planning management in the provinces encounters difficulties due to inadequate inspection staff and local authorities' failure to fine or to punish violations, while sewers and canals are extensively degraded by local residents. Failure of local authorities to control urban development which does not follow approved development plans also creates more difficulties.

Another issue relating to wastewater planning is the Vietnamese effluent discharge standards. The established values in these standards are relatively stringent, so capital requirements and revenue to pay operations and maintenance (O&M), skilled managers and operators, etc. is significant. Furthermore, the treatment solutions designed and built are often not appropriate for the present wastewater composition, especially in the areas equipped with combined sewerage systems, inclusive of on-site septic tank treatment. With the limited resources available, only a limited percentage of urban population is provided with wastewater collection and treatment services. It would be more appropriate to adopt a phased implementation strategy, where the standard of treatment is initially relaxed, but increased after some period of time in accordance with the increase in influent concentrations, eventually meeting Vietnamese standards. In doing so, the current coverage of urban sanitation could be significantly increased within the same amount of invested capital and other resources.

The syndrome of the ''investment requests'' in which every province is trying to have its own airport, deep sea port, industrial zones, etc. should not be repeated with wastewater treatment. Those low efficiency investment lessons show that lists of prioritized wastewater projects should be carefully considered at the National and Sectoral levels. With current limited Government budget and capacity constraints, resource allocation for wastewater collection and treatment projects should focus on the most crucial areas where wastewater pollution is severely damaging public health and the environment and where socio-economic development is important not only at the local, but also on a regional scale. In our opinion, the following areas should be given priority for urban wastewater systems investment: (a) coastal cities with intensive industrial and tourism activities; (b) central urban areas of core socio-economic development zones in North, Central and South; and (c) dynamic urban centers impacting downstream in key river basins. Apart from prioritizing the Government budget, mobilization of other resources is necessary. Appropriate policies are required to encourage private sector participation in wastewater projects in areas where potential business benefits are more promising than in low income areas. The latter areas can be compensated by good urban sanitation planning where suitable land is reserved for application of low-cost wastewater collection and treatment systems.

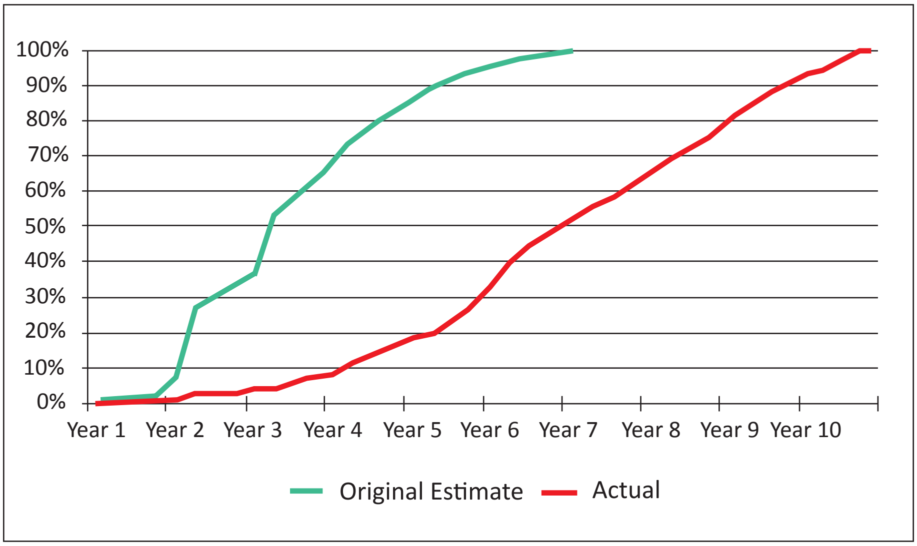
2. Wastewater Project Implementation

In urban sanitation projects, the total contribution from the Government and donors is much higher than contributions from households (77 versus 23 percent) (Nguyen V. A. et al, 2012). Major funding still comes from overseas development assistance (ODA grants or loans) compared with local and central government contributions (56 versus 21 percent). There are number of issues identified by the study team relating to project implementation as follows:

- Differences in regulations of Vietnamese government and other donors stipulating cross cutting issues make project implementation difficult.
- Involvement of urban sewerage and drainage companies who will be responsible for operation and maintenance of the system during the early stages of project design and project implementation is often limited.
- In many cases, a service delivery model has not been selected in the project design and project implementation stages. This limits efficiency of technology transfer and training activities, which are very important for system handover. This can lead to project failure due to inconsistency of the system design and its operational requirements. Fragmentation of responsibilities and gaps among involved stakeholders limit the project efficiency.

Most of projects are implemented with slow progress and low disbursement. The preparation period for a sanitation infrastructure development project averages 3 - 4 years (about 2 years in other countries). Implementation averages in 7 - 9 years (about5 years in other countries) (Figure C16) *(Le D. H., 2011).*

Figure C16: Typical ODA Project Implementation Progress, Actual versus Plan



Source: Le. D. H., 2011

Major reasons for delayed progress are:

- long procurement and site clearance periods due to inconsistency of the government's land compensation policy, significant design changes, and low capacities of the implementing parties;
- high inflation;
- unforeseen difficult site works;
- in some cases, the project costs increased significantly, requiring local authorities to reduce the works or to seek additional financing; and
- inadequate resources mobilized for capacity strengthening for the service providers (i.e., on human resource training), and lack of necessary budget from the local counterpart.

Limited capacity of the project management unit (PMU) staff is also a common issue, requiring separate discussion and analysis. The PMUs are temporary bodies which only exist until the end of their projects. The management problems of each PMU are different depending on their experience in managing previous projects. The institutional location of the PMU depends on the project and could be with the PPC, service providers or other institutions. Limited PMU capacity in project management is evidenced by the slow rate in carrying out site clearance for construction; inefficiencies in managing and monitoring the principal contractors; weak financial management (slow in making disbursements for projects and for contractors); lack of technical sanitation personnel; poor knowledge of the procedures of basic construction; and limited knowledge of the bidding process of Vietnam and the donors. Poor English skills are also a common barrier in project implementation.

3. Wastewater Project Efficiency

A recent study, Economic Assessment of Sanitation Interventions in Vietnam, by WSP, WB (*Nguyen V. A. et al, 2012*) has shown the average benefit/cost ratio (BCR) are > 1 for all surveyed sanitation interventions, ranging from 1.4 to 7.5 (actual values) for the options in urban areas. These values could be higher if project efficiency was in turn higher, given the application of the same interventions. Hygiene interventions added to health benefits give higher BCRs than sanitation interventions alone. The reuse of treated wastewater and sludge also adds economic value at relatively low cost. The study found that in most urban sanitation projects, the challenges faced are technological option selection, quality of design and construction often linked to consultant competency, administrative appraisal procedures, low rates of household connection, financial sustainability, local capacity for operations and maintenance (O&M), and monitoring, evaluation and control in the implementation stages (*Nguyen V. A. et al, 2012*).

A range of different sanitation technologies must be considered during project development. Local aspects to be considered include low-income communities, and topographical and other natural socio-economic conditions. An explicit assessment of the options should be made, for example: a combined sewerage and drainage system versus a separate system; centralized versus decentralized sanitation schemes; conventional versus high-tech or low-cost technological options; or a combination of these.

Neglecting a tertiary sewerage and drainage network is a common problem in urban sanitation projects. The use of common combined sewerage and drainage networks in urban areas in Vietnam is among the primary challenges that often lead to system overloads and/or water source pollution. Financial and economic lessons from new urban sanitation systems should be studied. The sanitation options analyzed in this study are: separate small-bore sewerage; decentralized or centralized low-cost wastewater treatment options in baffled septic tanks with anaerobic filters(BASTAF); constructed wetland and waste stabilization ponds in Buon Ma Thuot city (Dak Lak province), Cho Moi and Cho Ra towns (Bac Kan province) and Bai Chay tourist area (Quang Ninh province); and wastewater reuse in Buon Ma Thuot city (Dak Lak province).

Connection rate, combined sewerage versus actual WWTP capacity

In Vietnamese urban centers, the rate of household connection to drainage and sewerage system is low. The presence of septic tanks and an unsealed combined sewerage – drainage system are also reasons that the present utilization of the treatment plants capacity in terms of hydraulic load and pollution load is rather low. Underutilization poses a threat to the sustainability of the systems constructed. The environmental improvements envisaged are not realized due to the fact that many households are not yet connected and do not provide revenue to recover O&M costs. In order to solve this problem, household connections should be mandated by local authorities. The practice of mandated house connection was successful in Buon Ma Thuot in connecting over 85 percent of the possible household connections to the separate sewer system constructed.

The efficiency of targeting and utilization of funds

The primary source of funding of urban wastewater system investments has been Overseas Development Assistance with government funding playing a secondary role. Private sector investment in wastewater infrastructure is found only when owners of new urban areas invest in infrastructure for their real estate projects. A first case of the Build – Transfer (BT) modality has been pioneered in Hanoi city (Yen So WWTP, by Gamuda Company from Malaysia).

Property taxes and personal income taxes have not been used as instruments to generate increased financial resources at provincial and central government levels. This source of funding should be considered as one of potential sources for wastewater projects. Users' fees are inadequate, resulting in a need for local public budgets to cover the cost of operation of the utility systems.

As discussed above, administrative capacity for preparation and implementation of investments has been limited, resulting in delays and even resulting in discontinuation of project preparation. This contributes in lowering efficiency of the allocated funds for wastewater projects. management models for the utilities embody a risk of ineffective allocation and use of funds.

System operation and maintenance, quality of delivered service

Some urban sewerage and drainage/public works companies are operating effectively. Their performance has especially been improved following infrastructure development projects where capacity building components were designed and implemented properly. In addition to ''work by order'' activities paid from the city budget, a number of initiatives have been developed aiming at optimizing work procedures and improving work efficiency. Examples of good performing public works utilities, with good ownership and significant improvement initiatives, are the Ba Ria – Vung Tau sewerage and drainage company, the Da Lat

Figure C17: Making Compost From Sludge at the Da Lat WWTP

Photo by Nguyen V. A., 2012

water supply and sewerage company and the Buon Ma Thuot urban management and environmental sanitation company.

Figure C18: Inspection of Separate Sewer System Network with CCTV in Buon Ma Thuot City

Photo by Nguyen V. A., 2012

However, there are still a significant number of urban sewerage and drainage systems operated and maintained at ''minimum levels'' due to limited capacity of the operator and lack of funding. Information, education and communication activities are seldom carried out by urban sewerage and drainage enterprises -- which is the prime reason why public involvement in environmental sanitation is so limited.

In order to maximize the effectiveness and efficiency of the invested sanitation projects, the format of service delivery of urban sewerage and drainage systems should be improved. A contract-based relationship should be established between the city authority and the service provider – the sewerage and drainage company. A set of service quality criteria should be included within the agreement, in addition to providing quantitative indicators aimed at public health and environment protection at reasonable cost. Public utilities should be also provided with capacity building programs so that they could meet the city and public expectations.

4. Conclusions and Recommendations

With the current limited Government budget and capacity constraints, the following areas should be given priority for urban wastewater systems investment in the coming decade: (a) coastal cities with intensive industrial and tourism activities; (b) central urban areas of core socio-economic development zones in North, Central and South; and (c) dynamic urban centers impacting downstream in key river basins. Apart from prioritizing the Government budget, mobilization of other resources is necessary.

An integrated approach to implementation with components of water supply, sanitation and hygiene is likely to produce more sustainable results and more benefits. Safe and efficient resource recovery should be targeted in sanitation projects, especially in areas where funds are most limited. The reuse of treated wastewater and sludge in agriculture would bring significant benefits to the integrated sanitation system.

Sanitation planning should carefully consider the performance of alternative technology options and delivery approaches to maximize program efficiency. A strategic approach should be considered in terms of technology and type of systems (to be affordable and suitable for specific areas such as high density, already urbanized or new areas, larger or smaller cities, etc.). Proper planning processes would avoid inefficient investment in sanitation systems that are not financially sustainable or are inadequate for the population's needs and require later upgrading. The broader economic costs and benefits, as well as direct financial requirements and impacts, should be considered as part of the technology and program delivery selection. Technology selection and project design should take into account life-cycle costs, the future construction price increases, the specific conditions of target sites and the opportunities and limitations related to sanitation programs. Decision makers at all levels should be encouraged to participate in the selection of those technologies and designs that not only successfully capture the financial and economic benefits of sanitation, but also at an affordable cost in each specific context.

Balance in prioritizing and planning of household connections, the collection network and WWTP construction components should be highlighted in order to achieve investment efficiency and project sustainability. While the "top-down" approach requires large lump-sum financial resources and is implemented by relatively few, large public investments, the "bottom-up" approach can be pursued with smaller financial resources for a large number of very small investments. The latter approach may be financed by private capital, households or provincial budgets – even with central government target funds. The domestic credit market may also be tapped, either directly from commercial banks, or from domestic development banks. *A dual approach may combine centralized solutions for high-density urban areas, such as already built-up inner wards, with decentralized solutions for low-density peri-urban areas.*

Guidelines should be prepared for technology options and program delivery approaches for different geographical, demographic and socio-economic settings in Vietnam. To enable improved planning at a decentralized level, capacities and skills in planning, design and contracting by local authorities should be developed and mobilized. To increase program efficiency, a common coordinated database and standard design that incorporates improved environmental features should be made available. Vietnamese environmental standards need to be better developed to enable the planning of sustainable sanitation options.

Designated future operators of urban sewerage and drainage systems should *take part in the early stages of project design and implementation.* For improved sanitation project implementation, special attention needs to be given to building capacity among service providers and owners of sanitation services to improve program efficiency and sustainability. Different management models need to be considered based on a stakeholder assessment. Institutional strengthening and community development must be regarded as key components of water and sanitation projects. There is a vital need for the promotion and development of strong links and good coordination between water supply and sanitation companies and community organizations at all stages of project planning and implementation. An approach to implementation that integrates components of water supply, sanitation and hygiene provides more sustainable results and more benefits. Greater coordination of sector agencies is also required for programs to be efficient.

A combination of comprehensive wastewater management project components is crucial for project success in which resources are efficiently mobilized and utilized. Engineered facilities should be designed together with ''*soft interventions*'' such as capacity building, a management model and financial mechanism setting, a focus on preparedness for project handover and system transfer; household connections and wastewater treatment as well as wastewater and sludge reuse which should be considered together.

A clear *household connection policy* in urban areas with combined/centralized systems should be identified and enforced by regulation. A reasonable balance between the construction of treatment facilities and collection systems should be planned at each project stage.

Sustainable financing is closely dependent on the financing instrument, planning/technical aspects, and institutional / organizational arrangements. Furthermore, the most crucial period is during the O&M period, such that the project can be efficiently operated with the available resources. A key factor during the O&M period is the capacity of operator.

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Huey Douglas Pham	Country Manager, CDM Consultants, HCMC
Huynh Duy Tu Thieng	Deputy Chief Resident Engineer, CDM, HCMC
Dr. Paul Zuber	Technology Director, Biwater, UK
Le Thanh	Director, Phu Dien Company, Hanoi
Nguyen Phuong Quy	General Director, SFC Vietnam, Hanoi

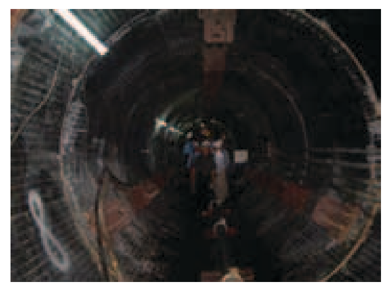
APPENDIX E- PHOTO ALBUM

Construction, Operation and Maintenance of Sewerage and Drainage Network

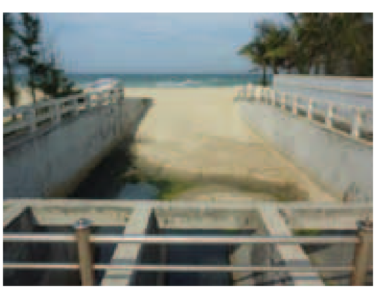
Open discharge of rainwater, grey water and septic tank effluent to street is a common picture in most cities

Nhieu Loc – Thi Nghe main interceptor is contributing to flood mitigation and environment improvement in HCMC

Installation of sewers in existing urban areas is always a challenging task



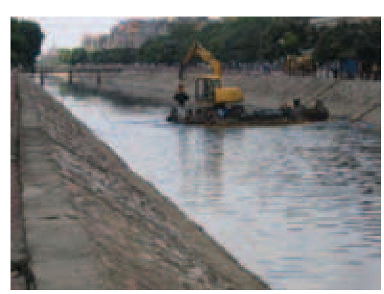
A new technology of pipe-jacking is applied for Nhieu Loc – Thi Nghe project, HCMC[(1)]



Open discharge to a tourism beach is a not-well-accepted solution[(2)]

Manual cleaning of combined sewerage in Hanoi city

Street manholes are not always maintained



Treatment and disposal of dredged sludge are issues

[1] **Photo Credits:** All photo by Nguyen Viet Anh, unless indicated: (1) Le Duy Hung; (2) Corning J.; (3) Da Lat Water Supply and Sewerage Company; (4) Source unknown; (5) Phu My Hung JVC; (6) Corning J.; (7) Vietnam – Germany Wastewater and Solid Waste Management Program.

In-operation WWTPs in Vietnamese Urban Areas

Truc Bach, Ha Noi (since 2005)

Kim Lien, Ha Noi (since 2005)

Da Lat, Lam Dong (since 2006)[(3)]

Buon Ma Thuot, Dak Lak (since 2006)

Hoa Cuong, Da Nang (since 2006)

Phu Loc, Da Nang (since 2006)

Ngu Hanh Son, Da Nang (since 2006)

Son Tra, Da Nang (since 2006)

In-operation WWTPs in Vietnamese Urban Areas (cont.)

Bai Chay, Quang Ninh (since 2007)(4)

Binh Hung Hoa, HCMC (since 2008)

Bac Thang Long, Hanoi (since 2009)

Ha Khanh, Quang Ninh (since 2009)

Nam Vien, PMH, HCMC (since 2009)(5)

Binh Hung, HCMC (since 2009)

Bac Giang (since 2010)

Yen So, Hanoi (since 2012)

Septic Tank Sludge Treatment Options Applied in Urban Areas in Vietnam

Septage holding and thickening is a major treatment step in Cau Dzien waste treatment station, Hanoi

Settling pond for septage treatment in Trang Cat, Hai Phong

Septage is discharged to inlet of Buon Ma Thuot WWTP for co-treatment with wastewater

Septage is delivered to Da Lat WWTP for co-treatment with wastewater

Sludge drying bed at Bai Chay WWTP.

Septage treatment station with lime conditioning and drying beds (not in operation) in Ha Khau WWTP, Ha Long

Septage thickening at Khanh Son waste treatment landfill, Da Nang

Septage composting for fertilizer at Da Phuoc waste treatment complex, HCMC

Challenges Faced in WWTP Operation and Maintenance

''Unused'' sludge drying machine in 2-year- operation Bac Giang WWTP

Diluted incoming flow from CSS makes installation and continuous operation of surface aerators unnecessary (Binh Hung Hoa WWTP, HCMC)

Handling with sludge is among key challenges

Hi-tech SCADA system does not operate in Bac Giang WWT

Diluted incoming flow from open canal of CSS is not suitable for invested hi-tech SBR treatment plant[(6)]

Due to rapid urbanization, this anaerobic pond has been covered. However, in order to meet effluent standard, the pond effluent will be soon pumped to the new WWTP for further treatment

BTL WWTP (Hanoi city) is under-utilized due to lack of sewer connections

Energy required for aeration at activated sludge WWTPs is among key challenges

Decentralized Sastewater Treatment Systems

Baffled septic tank and constructed wetland systems in Cho Moi town, Bac Kan province

Decentralized wastewater treatment plant for School in Vinh City[7]

Baffled septic tank and constructed wetland systems in Lai Xa Village, Hanoi sub-urb

Decentralized wastewater treatment plant in Kieu Ky Village, Hanoi sub-urb

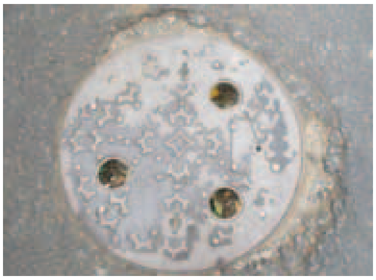
Decentralized wastewater treatment plant in Phu Cat, Hoa Lac, Hanoi suburb

Baffled septic tank for a new development area, Xuan Mai town, Hanoi

Packaged w/w treatment systems for villas at the National Congress Centre, Hanoi

Packaged w/w treatment systems for Eco-resort in Dong Anh district, Hanoi suburb

Utility's Ownership, Innovation and Creativity



Pressure releasing check valve developed by Da Lat WSS Co. to address flow overloads due to rainwater intrusion

Scum collector at Imhoff tank invented by Mr. Khai, Da Lat WSS Co.

Sewer cleaning in Buon Ma Thuot city

Sewer cleaning in Buon Ma Thuot city

Household connection manhole is being cleaned in Buon Ma Thuot

Treated wastewater is reused for coffee irrigation in Buon Ma Thuot

Composting of dried sludge for fertilizer production at Da Lat WWTP

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