ECONOMIC POLICY NETWORK

Policy Paper 23

SERVICE ENHANCEMENT AND DEVELOPMENT OF SANITARY SEWERAGE SYSTEM IN URBAN AND SEMI-URBAN SETTING IN NEPAL

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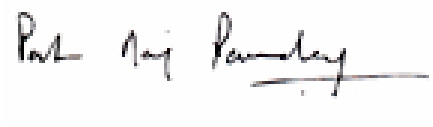
Inputs from various stakeholders during interactions at Advisory Committee meetings, and the workshop organized by the EPN Focal Unit, have been incorporated in the report.

Foreword

Economic Policy Network (EPN) initiated in August 2004 is an undertaking of the Government of Nepal with an Asian Development Bank (ADB) Technical Assistance (TA) to develop and institutionalize an open, responsive and result oriented economic policy formulation process based on sound economic analysis and dialogues with the partnership of public and private sector, academia, and independent professionals, to support and consolidate the Government's economic policy reforms on poverty reduction strategy. The initial focus has been in the areas of macroeconomic management; trade, investment and employment; infrastructure development; and tourism, agriculture, and regional development through four thematic advisory committees chaired by the secretaries of the respective implementing ministries, and guided by a high-level steering committee. The present study is an outcome of the initiative under the Advisory Committee for Economic Policy on Infrastructure Development chaired by the Secretary of the Ministry of Physical Planning and Works.

This report has attempted to make a critical review of current policy, plan and administrative procedures relating to waste water management in the country. The conditions of sewerage systems in selected areas and few establishments have also been analyzed. While dealing with overall services and delivery of sanitary sewerage system the focus is given to the issue of public private partnership. In this regard the responsibilities of local bodies and required institutional reforms are also highlighted in the study. The recommendations are the outcomes of consensus reached among major stakeholders through various consultations and the EPN workshop. I hope the findings and recommendations will be helpful for policy makers for future reforms.

I would like to thank Mr. Badan Lal Nyachhyon for carrying out the study. I also thank all those who have provided inputs for the report during the interactions, the advisory committee meetings, and the EPN technical workshop held in Nepal Administrative Staff College, Jawalakhel, Lalitpur. The work of the advisory committee for Economic Policy on Infrastructure Development is to be commended for selecting the issue and for following through with the study. I would also like to appreciate the entire EPN team for their hard work. Last but not least, I would like to thank the ADB for supporting this initiative.



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Preface

This paper is the second one in the series of EPN studies entrusted to me. The other paper deals with Urban Waste Management (Solid Waste, Liquid Waste, Air Pollution and Dust Pollution) and includes wastewater component. Majority of the plans and programs and policy reforms proposed in UWM is adopted here in this paper and supplemented with specific information and data based on existing condition.

The paper basically summarises the experience gained at national and international practice with particular focus on Sanitary Sewerage System and with some limited reference to On-site sanitation. The paper has made extensive reference to various papers, articles and policies adopted by regional and oversees governments and private sector. This is not a reinvention of the old wheel, but policing and trying to recast to suit the conditions of the country. In doing this, the experience of various organisations working in WWM in Nepal including private sector is extensively used.

Over the last few years, the topic of Public Private Partnership (PPP) for Sustainable Development was one of the hot issues on the national and international agenda. In an era of globalization and particularly with accession of Nepal into WTO and with highly constrained national resources and increasing public expectations, the Government alone was not able to fulfill the complex tasks of WWM. Today, the governments are obliged to seek more innovative ways of attracting private investments to meet the objectives of Development Plans. This issue is given some attention in the paper and more in depth is considered in Urban Waste Management (Refer 27).

In Nepalese context, wastewater management has been exclusive job of the Government and never been subject to partnership with the private sector. But rather it is subjected to regressive approach, denied for timely improvements and reforms by the Government and the donor agencies, and bundling with larger projects as Melamchi Water Supply with full knowledge that this kind of action will further delay the reforms. This paper primarily deals with Services and Development of Sanitary Sewerage System (SSS). Major focus is given to the issues of PPP and particularly on the Institutional Arrangement based on the ground reality. The paper also suggests certain activities of short-term nature that will contribute and visibly improve the conditions of WWM, if practically carried out.

Utilising this occasion I take privilege to extend thanks to all those who have made direct or indirect contribution in preparation of this paper including EPN, DWSS and NEA for their strong support to the proposed concept, wonderful cooperation provided in the consultative meetings with selected stakeholders and valuable advises provided through out the study. This paper had been discussed in three meetings with stakeholders i.e. Nepal Engineers' Association on July 21, 2006, EPN Advisory Committee on August 27, 2006 and EPN Workshop on September 11, 2006. Special thanks go to Er. Dhrub Thapa for his critical review of the paper, providing valuable advises and strong support to the proposed concept of wastewater management. Sincere gratitude is extended to the Ministry of Finance and Asian Development Bank for the new approach adopted in the process of preparation of this paper by recognising and entrusting the private sector specialists and developing the new model of partnership.

This particular recommendation was based on the in-depth understanding and guidance provided by Mr. Narayan P Silwal/Mr. JR Joshi, Secretary, MOPPW, Mr. DP Dhakal, and coordinator, EPN/MOF and Mr. IM Tamrakar, DG, DWSS.

Er. Badan Lal Nyachhyon

Preface
Executive Summary

Executive Summary

Sanitary Sewerage is a part of Wastewater Management that needs to be taken care of in order to reduce threats to public health, safety, and the environment. Wastewater can consist of industrial waste, human waste (or sewage), or runoff from rainwater. In this paper, the terms: “Sanitary Sewerage” and “Wastewater” are used in broader sense as synonymous to each other.

All of the wastewater produced by a city eventually ends up in a river or lake. On its way, this wastewater flows through a collector network sewers and a sewage treatment plant, collectively known as Sewerage System. Sanitary sewerage system is particularly related to the human and industrial waste rather than rainwater.

In Nepalese context, because of the notion that separate system for sanitary and storm water cannot be afforded, the authorities try to intermingle the sanitary and storm water with each other in a panicky way. Particularly, the interference of municipalities with the existing sanitary and storm water drainage systems without much regard to technical details is significant. As a result, both the systems are malfunctioned with breakdown of online pumping stations and silting of the collector sewers, stabilisation and oxidation ponds.

Many of the Urban and Semi-urban areas in Nepal rely on On-Site sanitation or Combined Sewers except for new construction. The traditional brick channels in Kathmandu and Lalitpur were built back in 1900s for storm water drainage and only in recent times after 1950s were converted into combined sewers with unauthorised connection of sanitary sewers. The new sewerage systems, of Kathmandu and Lalitpur core areas leading to Dhobighat and Kodku Treatment Plants respectively, are separate sanitary sewers and were constructed in 1980s. Other new extensions in Kathmandu and Lalitpur are combined sewers.

In conventional sewage treatment plants, bacteria remove up to 90 percent of biodegradable organic wastes before the sewage moves to a sedimentation tank, where remaining solids and dead microorganisms settle as sludge. The sludge is incinerated, dumped in a landfill, composted, or used as fertilizer. The remaining wastewater, still containing oxygen-demanding wastes, suspended solids, nitrates, phosphates, and toxic metal compounds, may pass through additional advanced sewage treatment before being discharged to the river or lake. The advanced sewage treatment may comprise of a tertiary treatment with a shallow oxidation pond followed by chlorination and dechlorination prior to release to reed bed, wetland or artificial marshland or rivers and ponds.

The Sewerage system in Bhaktapur with two treatment plants (Sallagarhi and Hanumanghat) belongs to combined sewerage category. The Guheswori Treatment Plant consists of Aeration with Activated Sludge and treats combined sewage from Gokarna, Chabahil, Boudha and Jorpati. Banepa, Dhulikhel, Hetauda, Bidur, Kamalamai and Dhadingbesi have combined sewerage system without treatment plants and dispose sewage directly into rivers. Panauti Municipality is using a sanitary sewerage system with the oxidation pond system. Bharatpur and Ratnanagar have no sewerage system and use on-site sanitation.

The communities as stakeholders, consumers and taxpayers are frequently required to fund for construction, extension or upgrading of local sewer systems and treatment plants. The recent extension of combined sewer systems in most of the urban areas in Kathmandu,

Lalitpur, Bhaktapur promoted by the municipalities belongs to this category and used partial investment by communities.

Most of the sewer systems (apart from Brick Channels and Roadside drains) in Kathmandu and other cities are made of concrete pipes and are very poor in design with collar joints, and constructed in open trench. Particularly, the collar joints, instead of spigot socket joints, are not properly made; lines and levels are not properly maintained; post construction clearance and water tightness tests were not carried out. The construction and maintenance of these sewers require disruption of the road surface and create disturbance to traffic and urban life. Contrary to this, the new method of sewer construction using "No Dig" technology with micro-tunnelling could be next direction of construction since it will substantially reduce the cost and time of construction (Appendix 3). Sewers from 150 mm dia to 3000 mm could be laid using appropriate mini tunnel boring machines.

There are altogether 6 WWTP (Dhobighat, Sallaghari, Hanumante, Kodku, Guheswori and Hetauda ID) out of which the first three are defunct. The Dhobighat and Sallaghari Treatment plants are defunct primarily because of disruption of pumping stations and lack of institutional capability to operate. All the three defunct WWTP are subject to the combined flow of sanitary and storm water. The investment made in these treatment plants is lying idle since 1995 or before. Although the effluent from these functional treatment plants looks clean enough at the end of the treatment process, there is no control made to ensure that pathogens have been destroyed. The WWTP in Kodku, Dhobighat and Sallagarhi are equipped with chlorination plants but were never operated. The associated sewer network to these WWT Plants comprise of concrete pipes

Seeking a more natural and less expensive approach to sewage treatment, various communities and municipalities as Kathmandu, Thimi, Pokhara and others had had implemented Reed bed treatment plants. Currently, more than 12 communities and towns in Nepal (Dr. Manoj Pandey, 2006) use Reed Bed Treatment Plants to treat sewage. But these Reed Bed Plants were developed without adequate sedimentation tanks and oxidation ponds (where bacteria breakdown the waste during a course of one month detention period), sludge removal and drying facilities and used at primary or secondary treatment level and has undermined the efficiency and environmental requirements of pathogen and chemical free disposal to rivers. The technology is still in Pilot Phase and requires a detailed performance evaluation study and technical audit to derive lessons for replication and use in future projects prior to further execution and implementation in other towns including the towns of Urban Environment Improvement Project financed by ADB.

The treatment plant at Dhulikhel Hospital is not functioning during monsoon period since there is not adequate system to retain the rain water and waste water is over flooded without treatment; the pipe systems and gravel filter media are chocked with accumulated sludge; the reed bed plants do not absorb other elements (Sulphur, heavy metals) than NPK. The reed plants become less effective as they grow and mature with roots blocking the effluent flow and less absorption of nutrients. Wastewater remains polluted. The Reed Bed shall be utilized only for tertiary treatment of wastewater from conventional treatment plants.

Besides wastewater from sewage, there is urban runoff water that flows down streets and into storm drains. The rainwater runoff flows untreated into the rivers or ponds. When this happens, the runoff also transports contaminants such as solid waste, dust, human and animal

waste, lub oils, grease, kerosene, soap, detergent, paint, heavy metals, leaves and twigs, and pesticides.

The purity of the water increases as it passes through a series of natural process in natural or artificial marshes or water bodies as river, where it is further filtered and cleansed by small animals, bacteria, moulds (algae, reeds) and subject to the wide range of acidities that result naturally from daily cycles of photosynthesis. To digest the dirt in the water, the small animals, bacteria, moulds need oxygen. When the animals, bacteria and moulds have to digest a lot of dirt, the oxygen decreases. When there is no more oxygen in the water, the bacteria, moulds and all other animals die and the water stays dirty. The only way to avert this from happening is watch the water for getting too dirty and don't let it run out of oxygen. Monitoring of the quality of wastewater becomes paramount with maintaining DO level at 3mg/l and BOD level less than 60 mg/l.

Based on the quality, wastewater is categorised into Black water (foul water) from toilet, Grey water (sullage water) from kitchen, bathrooms and rainwater (surface drainage) from roof terrace or courtyard. The treatment of various category of wastewater may be carried out differently since the scale of difficulty is different. The treatment of grey water or rainwater may be much more easier and for certain use the sophisticated treatment may not be required. For example, grey water may be directly used for watering gardens or reuse (If phosphates from detergents are controlled) for flushing toilets whereas black water requires full-fledged treatment and removal of e-coli bacteria. Wherever appropriate, encouragement shall be given for reuse of grey water and rainwater, and recycling of black water after treatment based on the affordability and economic return.

The wastewater issues in Nepal emerged with the development of piped water supply system commencing since 1895 AD, development of consumerism, and industrialisation. The haphazard urban development and uncontrolled migration of population from rural areas to urban centres, and lack of proper planning for wastewater management are the root cause of wastewater pollution of the water bodies and ground water (in Dhobi Khola area) in general and overloading of the existing sewerage system.

The total wastewater produced in the country ranges to the tune of 370 MLD, out of which the installed WWTP account for only 37 MLD (10% of total demand) and functioning WWTP accounts for 17.5 MLD < 5% of total demand.

The sanitary sewerage system in Nepal practically failed with the withdrawal of the donor support inviting huge environmental hazard and damage to human health. The management issues of ownership, institutional capacity, operation and maintenance, behaviour of the users and timely expansion of these systems are the root causes of wastewater system failure..

The river systems in many urban areas are permanently polluted with wastewater discharge and solid waste dump that destroyed aquatic life and contaminated the ground water. Some of the reasons for pollution of river systems are lack of ownership by Law of river basins; neighbourhood municipalities are not responsible for their care; illegal encroachment of river banks are not monitored; misuse of river basin for construction material abstraction; Civil Societies are not properly empowered. It may be worth to assign the ownership of river systems to an Exclusive Agency who will be responsible for conservation in line with concept of King Mahendra Trust for Nature conservation.

Apparently, there is no easy way to bring back the rivers into their original natural conditions. It is obvious the combined effect of disposal of solid water and wastewater in Bagmati and Bishnumati rivers may be improved only after radical policy reforms including institutional reforms.

Nepal has made very important policy changes and is a signatory to a number of international environmental conventions including Kyoto Protocol. Nepal also has had prepared certain plans and programs related to WWM. Some of the important policies, international conventions and plans are as follows:

a. **Constitution of Nepal**, 1990 that guarantees the civilian right for clean environment
b. **National Water Supply Sector Policy, 1998** that requires to provide safe, convenient and adequate water supply with sanitation
c. **The Tenth Plan** that focuses on providing sanitation facilities by increasing peoples' awareness, encourage consumers' group for construction of sewerage drainage system with filtration plant for [creating] unpolluted urban environment, encourage construction of private toilets with safety [Septic] tanks in the areas where there is no sewerage drainage system, and discourage the tendency of discharge of sewerage in the surface water drainage and rivers, and encourage to the local authorities for establishment of Sewage TP with nationwide coverage of 60% by year 2007;
d. **The Twelth Plan** aims to prove 100% sanitation facilities by year 2017.
e. **RWSS National Policy and Strategy 2004** that has made commitment to provide safe, accessible and adequate water supply with sanitation facility to all the citizens on priority basis especially targeted to the backward people and ethnic groups.
f. **Draft Policy of Waste Water Management, 2006** that provides guidence for project peparation, improvingsanitary conditions, facilitating construction and management of [separate] storm and sanitary sewerage systems. Improving sanitary condition of rivers and lakes, and encouraging PPP;
g. **Environmental Protection Act 1997** that requires IEE/EIA studies for major projects,
h. **Local Self-Governance Act 1999** that encourage the inhabitants of wards for maintaining sanitation, environmental protection, pollution control,
i. Ratification of **Child Labor Law** that eliminates child labour with age below 18 in hazardous works,
j. **Millennium Development Goals Agenda 21** calls for *Governments and other stakeholders to make the sanitation crisis number one agenda, and empowering the local authorities with professional capability to deliver water supply and sanitation services.*
k. **Kyoto Protocol** that limits disposal of SW on land, waste water handling, waste incineration and emission of greenhouse gas as methane and carbon dioxide, and encourages carbon trading from developing countries to developed countries.
l. **Public Private Partnership Policy, 2060** (2004) and Guidelines, 2061 (2005)

The implementation of the plans, programs and policies is the weakest part in WWM in Nepal and is aggravated by the lack of will power and commitment. There is a visible gap in Policy, Legislation and Commitments and lack of agencies for advocacy, monitoring, surveillance and performance auditing.

WW management is given least priority with almost all wastewater discharged to the river systems. No policy related to the Wastewater Management has been formulated.

The rehabilitation of Dhobighat, Sallaghari and Hanumanghat WWTP are bundled with Melamchi Water Supply Project. This matter may be considered for unbundling from Mega Project that are difficult to implement and could be a good case for developing PPP.

All stakeholders including individuals, communities, business houses, industries, and institutions produce waste. But the management responsibility is vested on the Municipality or the central government alone beyond its capacity. This is one of the reasons for mismanagement and environmental hazards created. As envisaged by the Tenth Plan, encouragement shall be given for application of the principle of "Central Policy Making and Decentralized Implementation" and the participation of the stakeholders.

Based on the lessons learnt from the past and with consideration of the ground reality, it is essential to take a hard decision and determine a direction which way it is desirable to develop the sanitary sewerage system. The approach for selection of Sanitary Sewerage system may be based on following principles:

1st Principle: Waste Management at Source
2nd Principle: Choice of Technology based on Environmental Standards and Economy
3rd Principle: Consensus Building and approval by Stakeholders and competent authority
4th Principle: Follow up, Monitoring & Evaluation, and Auditing.

The Sanitary Sewerage System for various category of urban areas may be as follows:

- Semi-urban and Rural areas: On-Site Sanitation comprising of Pits, Septic Tank, Eco-san toilets with urine separation, Cesspool (with Aeration system in future)
- Institutions/organisations as hospitals, housing complexes, educational campuses and universities, industrial houses and other organised sector: Independent Sanitary Sewerage System with treatment facilities within their own premises (Package Treatment Facilities) and with strict prohibition of discharge of effluent into Nature or City Network.
- Small Communities: Package Treatment Facilities or Use of improvised Biogas Plants with methane gas recovery facilities
- Existing sewer systems in core city areas: The existing sewer system in Kathmandu Valley towns and other cities as Panauti, Dhulikhel, Hetauda, Bidur, Kamalamai and Dhadingbesi require rehabilitation, recovery of the assets and bring into the functioning, and gradually transfer into separate system
- New urban areas with dense population: These areas may prefer Separate System and, if necessary, may combine with Septic Tank and small bore plastic sewers with Aeration Lagoon as the basic sewage treatment facility.
- Household Aerated Wastewater Management: The technology may have advantage and may eliminate the need for separate sanitary sewer system with utilisation of surface water drainage for disposal of quality effluent from households. Or alternatively, promoting small bore sanitary sewerage consisting of plastic pipes, eliminating manholes and utilising aerated sludge / bio-filter treatment plants.

The basic sewage treatment method will remain the development of Aeration Lagoon facilities with application of Advanced Treatment System based on the actual need and severity of the local conditions. The selection of the system will be guided by the

environmental guidelines, economy, ability to handle sludge volume and its marketing as compost and soil conditioner, besides land availability, energy prices, skill and management capacity, affordability and environmental standards to be maintained.

Combined Sewer system with mixed sanitation and surface drainage would be the least preferred system that needs to be gradually improved to separate system**.**

The lessons learnt from the good practices indicated that the responsibility of WWM is vested in various organizations in a scattered manner. The plans and programs are not coordinated and not agreed with. At the same time, it is observed that the wastewater management has relatively better performance where community/stakeholder participation is strong. For example, the people of Shankhu had driven away the carpet industries established at the upstream of Shalinadighat and helped to preserve the natural environment.

The gap in policy implementation and advantage of community involvement has advocated the need for establishment of **an exclusive and dedicated organization** as a first step for Policy Reforms, strengthening Public Private Partnership, making choice on technology and management, clearance of projects, surveillance of performance of the stakeholders, conducting technical audit and consensus building. The proposed Exclusive Organisation for WWM may utilise the institutional framework proposed for Urban Waste Management, the NCUWM, for consolidating and avoiding the duplication of efforts. It will be of great advantage for WWM to join the proposed NCUWM, if approved by the Government (Refer 27). The proposed NCUWM will be a partnership of representatives of stakeholders without limitation and strengthened with establishment of local level executing councils, empower and strengthen the existing executing agencies with the support of the proposed parliamentary committee, environmental audit committee, civil societies for surveillance of activities, and UWM Fund. The roles and responsibilities of the National and local councils are provided in Appendix-6. NCUWM will be functional under the institutional framework of the Cabinet of Ministers and will report to the Prime Minister's Office.

The first approach to enhancement of Sanitary Sewerage Services in Kathmandu Valley would be to restore the existing system into function, gradually eliminating the weaknesses of the past and encouraging separation of storm water and sewage, and allow proper treatment, search for cost effective methods of treatment with reduction of cost to the consumers. The wastewater treatment at source, if could be introduced, would be ideal. The recommended Action Plan is summarised in Table 1.

Wastewater collection and Treatment are local issues and shall be executed at the local level. For this reason, the available human and fiancial resources may be required to divert to the National and local level agencies. This will require major changes in approach and developing understanding at public and private sector.

The capital resource required for development, operation and maintenance of SS will be possible to raise from the formal and informal private sector provided attractive and pragmatic motivational and incentive schemes are developed. The problem raised due to starvation of capital resources for the formal and informal sector will be solved in many ways. The capital inflow and support of the banking sector may be possible if economically viable combination of resource mobilization approach could be derived and PPP is established.

The fund for WWM is envisaged to evolve from the WW tax and Revenue, grants from the central and local governments, Saving of costs induced by the proposed Reforms and Revenue from Outsourcing of Services. The Sewerage service fees may be charged based on the quality of effluent disposal following the proposed disaggregated revenue system, and will be a part of Urban Waste Management Fund.

Creation of Incentives as economic tools as Reward and Punishment would be most important driving force that will be helpful to motivate to the consumers for implementing the Waste Management at Source approach and identifying innovative approach in Waste Management leading towards reduction of waste generation and eliminate “Throw Away Practice”.

The consultation with the stakeholders, professional groups and EPN Advisory committee and workshop has suggested for a score of supplementary studies for enhnacing the effectiveness of the policy documents and to rationalise the proposed activities with pragmatic approach and actions. The suggested further supplementary studies are listed in Appendix-8.

The Policy Reform related to Sanitary Sewerage System should include provision for review of Legislation, Acts Rules and Regulation to incorporate Social and Corporate Responsibility of all stakeholders and incorporation of provisions for Waste Management at Source and Annual Environmental Audit of Corporate bodies including individual Households. Particulalrly, the Town Development Act, Building Bye Laws, Company Act, LSGA, periodic plans and WWM Policy.

A Policy Action Matrix for the initial period is reproduced below. It has been developed based on constrains and issues related to WW. The matrix also indicates the list of activities, measurable indicators, the potential responsible organization and time period. More detailed matrix is provided in Appendix-5.

Table 1: Proposed Action Plan for Wastewater Management

Constrains	Recommendation	Proposed Activities	Responsible Organisation	Timeframe
Policy Reforms	Develop Waste Water Management Policy	- Review existing Policies scattered over various Legal Documents, Acts, Agreements - Consolidate Policy Documents - Prepare WWM Policy - Develop Consensus among the stakeholders	Cabinet of Minister, DWSS	Immediate
Institutional Framework	Establish an Exclusive and dedicated organisation	- Consensus Building on the proposed Exclusive Organisation for WWM at national level or join the proposed NCUWM, - Establish Local Councils for WWM or join LCUWM, - Establish supportive committees and Empower Civil Societies - Adopt Office of the Prime Minister as the Line Agency	Council of Ministers, NPC, DWSS	Immediate
Vision, Goal and Objectives	Develop Vision, Goals, Objectives and Purpose	- Carry out Objective analysis - Propose any changes in the policy and objectives - Advocate for The Principle of Waste Management at Source - Consolidate Purpose - Develop Consensus	EOWWM /NCUWM, Stakeholders	Immediate
Implementation Strategy	-	- Make policy decision on Separate and Combined Sewerage Systems - Build Capacity of Executing Agencies at local level - Develop Marketing Strategy for Sanitary Sewerage Services - Support further Studies, Research and Development - Develop PPP Programme - Strengthen relationship with communities - Generating More Water by introducing water conservation plans, encouraging reuse of grey water and using rain water - Intervention in the Existing System for rehabilitation - Encourage Innovative Approach for New System as aerated wastewater treatment at source		
Proposed Activities	- Define Approach - Introduce WWM as Social and Corporate Responsibility	- Define Roles and Responsibilities - Prepare Detailed Programs (Appendices-3, 4 & 7) - Support Reform of Acts, Regulations, - Support Awareness Building, Capacity building, and Empowerment - Develop Financial and Investment Framework - Develop Manuals of Procedures and Procurement Framework - Establish Data and Info Centre - Establish WWM Fund as part of UWM Fund	Cabinet of Minister, NCWWM / NCUWM/ DWSS Stakeholders	Immediate

Constrains	**Recommendation**	**Proposed Activities**	**Responsible Organisation**	**Timeframe**
Proposed Activities	Services Delivery	- Separate Sanitary Sewer and Surface Water Drainage - Carry out Feasibility of Waste Management at Source/Biofilter WWTP at Outfalls to rivers - Carry out Feasibility of Outsourcing Sanitary Sewerage Services (Cleaning and repair) See Appendix-4	**NCUWM**	Immediate
	Development of Sanitary Sewerage	- Promote On-site sanitation as Basic sanitation System - Promote HH Aerated WWM and or pressure sewers eliminating sanitary sewers, - Carry out Feasibility Study of using Dhobighat WWTP for Patan South Sewerage Zone		Immediate
		- Evaluate Potential for PPP in WWM in 5 Municipalities	Service Contract	Long Term
		- Support WWTP Development by Private Sector	DBO / BOT	Long Term
		- Support Entrepreneurship for Sewerage System operation and Business for sludge reuse and WWM	Private	Long Term
		- Explore Unbundling of 3 WW Plants in KV from Melamchi Project (Dhobighat, Sallaghari and Hanumanghat WWTP)	Service Contract	Long Term
		- Carry out Policy Reforms in Town Development Act, Building Bye Laws, Company Acts and prepare Wastewater Management Policy and introduce provision for Annual Environmental Audit	NCUWM, Related Executing Agencies	Long Term
		- Provide Support for further Studies and Research on Issues of WWM (Appendix-8)	NCUWM, Related Executing Agencies	Immediate
Motivation, Incentives	Introduce Motivation for Good Practices	- Develop Scheme for Motivation, Incentives and Awards - Support Innovation, creative Ideas and RD - Recognise unsolicitated offers	NCUWM	Intermediate

Chapter I

Background and Introduction

1.1 Initiation of Sewerage System

Initiation of sewerage system in Nepal started with the start of piped water system, Bir Dhara water supply system, back in 1895 AD. The combined sewerage system of brick channel developed towards 1920s in Kathmandu (44 KM) and Patan (11 KM) is still operating as main sewer. Certain private toilets were gradually connected to these brick channels without much consideration of consequences. Otherwise private toilets at the palaces, in the residence of aristocrats and public toilets were served with wastewater containers that were removed and transferred to farm lands or river by certain class of people called" Podays".

Prior to 1960, the people used open field, farmlands, ponds or riverbanks for defecation. In municipal areas, specifically in Kathmandu, Lalitpur and Bhaktapur, special areas known as "Khikhan Mugah" located at the outskirt of the settlements, were used for open defecation. The excreta was partly fed to pigs raised in the locality by the Podays and street dogs.

With the introduction of piped water supply system, the public or private toilets were gradually introduced with wastewater being disposed of in the nearby surface water drainage, irrespective of being whether open or closed, converting them to combined wastewater system. Focus on toilet construction was given along with construction of Sundarijal Water Supply System in 1963.

1.2 Key Words

Sewer, Sewage, Sewerage, Sanitation, Grey water, Black water, wastewater, Cesspool, Septic Tank, Pit Latrine, Yard type Latrine, Fully Plumbed Toilet, Sullage, Sludge, Oxidation Pond, Aerobic digestion, Anaerobic digestion, Reed, Activated sludge, Wetland, Effluent, Affluent, Landfill Site, Incineration, Interceptor, Storm water, Drainage,

1.3 Rapid Urbanization and Wastewater Demand

Rapid urbanization, change in consumption habit and negligence towards preservation of environmental condition brought new scenario of urban and rural areas with disposal of waste water and industrial effluent into the river systems or into ground water through septic tanks. The rapid urbanisation has created severe demand on Wastewater Management but less priority was given to the issue of WWM. The indicative urban growth and the wastewater demand for Major 10 cities are summarised in Table 2 and details provided for other cities in Appendix-2.

Table 2: Urban Growth and Wastewater Demand

SN	Urban Centers and District	Pop 81	Pop 91	Pop01	Growth Rate 81-01 %	Pop 05	WW Demand, MLD
1	Kathmandu (Kathmandu)	235,160	421,258	671,846	5.39%	**790,612**	63.25
2	Pokhara (Kaski)	46,642	95,286	156,312	6.23%	**186,410**	14.91
3	Lalitpur (Lalitpur)	79,875	115,865	162,991	3.63%	**183,316**	14.67
4	Biratnagar (Morang)	93,544	129,388	166,674	2.93%	**182,331**	14.59
5	Birganj (Parsa)	43,642	69,005	112,484	4.85%	**133,244**	10.66
6	Dharan (Sunsari)	42,146	66,457	95,332	4.17%	**108,605**	8.69
7	Bharatpur (Chitwan)	27,602	54,670	89,323	6.05%	**107,162**	8.57
8	Janakpur (Dhanusha)	34,840	54,710	74,192	3.85%	**93,796**	7.50
9	Dhangadhi (Kailali)	27,274	44,753	67,447	4.63%	**92,326**	7.39
10	Butwal (Rupandehi)	22,583	44,272	75,384	6.21%	**91,737**	7.34

1.4 National Sanitation coverage

The national coverage of sanitation is currently assessed at 27% in 2001 and 46% in 2004.

Table 3: National Sanitation coverage, %

SN	Parameters	1990	1995/96	2000	2001	2003/04	2005
1	Nepal				27%	46%	
2	HH with own toilet facilities, %, *1		21.6 %			38.7%	
3	Access to Sewerage system, *1				25%		
	National Average, %, *1					12.1%	
	Urban Areas average, % *2					54.4%	
	Kathmandu Valley, % *2					98.1%	
4	HH with access to onsite sanitation, %						
5	Access to Improved Sanitation, *3				25%		
	Urban Area	69%		73%		76%	
	Rural Area	15%		22%			

*1 National Living Standards Survey 2003-04

*2 Figures indicated by The National Living Standards Survey 2003/04 probably refers to the core area. These figures considered very high for the urban areas and Kathmandu Valley as a whole.

*3 WHO/UNICEF

1.5 Initial Development of SSS

In late 1970s and early 1980s, there was limited effort to introduce the sanitary sewerage systems and was confined to Kathmandu, Lalitpur and Bhaktapur City core areas with wastewater disposal diverted to the Sewage Treatment Plants at Hanumanghat, Dhobigat, Kodku and Sallaghari. These treatment plants comprise primarily of oxidation ponds.

Despite of significant efforts in the last decades, the majority of the municipalities including Kathmandu and Lalitpur could not manage the growing volume of wastewater. As a result of the steps established by Kathmandu and Lalitpur Municipalities, the whole nation imitated the wastewater management procedures creating numerous environmental and health hazards. The problems are aggravating from day to day due to generation of wastewater from unplanned urban growth, shortage of drinking water supply, and inability to extend the

sanitary sewerage system and use of roadside and storm water drainage system for sewage disposal. Ultimately, the sewage is dumped in the rivers without any kind of treatment. In due course of time, the treatment plants constructed with the donors' funds and loan were dilapidated and became defunct.

1.6 Waste Water components and its Sources

In the environmental context, wastewater delivered at the Sewerage treatment plants comprises of:

- Black water, Grey water and Sludge
- Industrial effluent and Sludge
- Green Plants from STP Lagoons
- Silt, Sand and Solid Waste discharged from combined sewers
- Surface drainage discharged to Sanitary sewers
- Solid Waste and Construction Debris dumped in the sewerage system
- Treated affluent

The major sources of Wastewater are Households, Streets (public toilets), Business/Institutions, Healthcare Organizations, Industries and Construction sites.

1.7 Category of Households based on Sanitary System used

The Households including institutions and business, industries are categories based on category of Sanitary Systems used. They are:

- HH with no sanitation system (People defecate in open field and river banks)
- HH with on-site sanitation (Fully plumbed and Yard type toilet and kitchen)
- HH with sanitary sewerage system (Fully plumbed and Yard type toilet and kitchen)

1.8 Basic Components of Sanitary Sewerage System

The basic components of the sanitary sewerage system comprises of following elements:

- Sewage Inlet box at Households (for HH with Sewerage system)
- Onsite sanitation pits, Septic Tanks or Eco-San toilets with urine separation (for HH without Sewerage system)
- Home Aerobic WWT (Currently not used in Nepal, but may have potential infuture)
- Feeder Sewerage network from consumers properties
- Collector Sewerage System
- Sewage Treatment Plant
- Sludge Drying Bed
- Sludge Disposal Area
- Polished Affluent disposal outlet.

1.9 Existing Sewer Network and Treatment Facilities

The wastewater generated in the country has not been studied and recorded as such. In majority of the urban and semi-urban settings, the wastewater generated from households and industries is mostly directly diverted to the natural river system without proper treatment.

The efforts for treatment of liquid waste, particularly, of domestic waste water is concentrated in Kathmandu Valley, to some extent in Pokhara and treatment of industrial waste water in Hetauda. The sewer network and wastewater treatment plants established upto date are summarized in Table 4. The total installed capacity of the existing treatment plants is less than 10% of the total demand for the 58 municipalities.

Table 4 Existing Sewer Network and Waste Water Treatment Plants

Existing WWT Plant	Type of Plant	Plant Capacity and condition		Associated Sewers
		Capacity MLD	Condition	
Dhobighat, *1	1st Pond – Aerobic 2nd Pond –Anaerobic 3rd Pond – Facultative 4th Pond - Aerobic	15.4	Not in working condition	HH Connections – 53,900 Sewerage Lines - 61,650 M Combine channel - 44 KM Combined Sewers–? Unknown Pipelines-? Unknown HH Connections-?
Kodku, *1	1st Pond – Aerobic 2nd Pond –Aerobic 3rd Pond – Facultative 4th Pond - Aerobic	1.1	Partially Working	HH Connections – 15,500 Sewerage Lines - 20,443 M Combine channel - 11 KM Combined Sewers–? Unknown Pipelines-? Unknown HH Connections-?
Sallaghari, *1	Activated Aeration Ponds	2.4	Not in working condition	HH Connections – Sewerage Lines - Combine channel -
Hanumanghat, *1	Oxidation Pond	0.4	Not in Working Condition	HH Connections – Sewerage Lines - Combine channel -
Guheswori, *2	Oxidation Pond	16.4	Working	Sewers – 6 Km Population Served - 53,000 Urban Area - 21 Ha
Hetauda ID,	Oxidation Pond	1.1	Working	Sewer Lines- Industries Served -
Dhulikhel hospital, *3	Reed Bed Plant	< .010	Without Primary Treatment. Working (?)	Influent-WW, Bed Size-261 m2 Population Served- 330 Operation date -1997
Kathmandu Municipality	Reed Bed Plant	< .040	No Primary Treatment	Influent-Surface Bed Size-362 m2 Population Served- 330 Operation date -1998
Malpi International School	Reed Bed Plant	< .025	No Primary Treatment	Influent-WW Bed Size-376 m2 Population Served- 850 Operation date -2000
SKM Hospital	Reed Bed Plant	< .015	No Primary Treatment	Influent-WW Bed Size-141 m2 Population Served- 500 Operation date -2000
KU, *3	Reed Bed Plant	< 0.035	No Primary Treatment	Influent-WW Bed Size-587 m2 Population Served- 1300 Operation date -2001

Middle Marshyangdi Hydropower Project	Reed Bed Plant	< 0.026	No Primary Treatment	Influent-WW Bed Size-298 m2 Population Served- 870 Operation date -2002
A private House	Reed Bed Plant	<0.005	No Primary Treatment	Influent-GW Bed Size-6m2 Population Served- 5(?) Operation date -1998
ENPHO Laboratory	Reed Bed Plant	<0.01	No Primary Treatment	Influent-GW Bed Size-15 m2 Population Served- ? Operation date -2002
Pokhara Municipality	Reed Bed Plant	< 0.115	No Primary Treatment	Influent-S &L Bed Size-3308 m2 Population Served- 3830 Operation –Under Construction
Kapan Monastry	Reed Bed Plant	< 0.015	No Primary Treatment	Influent-WW Bed Size-150 m2 Population Served- 300 Operation –Under Construction
Tansen Municipality	Reed Bed Plant	<0.030	No Primary Treatment	Influent-WW Bed Size-583 m2 Population Served- 1000 Operation –Under Construction
Total installed capacity		< 37		

Source: ICIMOD/MOPE, CES/Multi 1993, HIDM 2004, HPCBASIP
Note; *1 Bundled with Melamchi Project, *2 wastewater comprises of mixed Industrial and Domestic waste, *3 Pipes and Filter media chocked, dead zones created

1.10 Waste Treatment Methods

The treatment methods used for the various category of urban waste are indicated in Table 5.

Table 5: Waste Water Treatment methods and Degree of Hazards

Methods of Treatment	Degree of Hazard to Environment and Health								
	Human Health	Ground Water	Source Water	Water Supply	Earth Surface	Vegetation	Air	Environment	Cost Implication
Direct Disposal to River	H	H	H	H	H	H	H	H	H
Septic Tank	L	H	M	M	L	L	L	H	H
Oxidation Pond	L	L	L		L		L	L	L
Reed Bed (Secondary Treatment Level, without pathogen Control)	H	H	H		H		H	H	H

Key: H-High, M-Medium, and L-Low

1.11 Waste Induced Health Hazard

Many people think waste goes away when it is dumped. The wastewater contaminates the ground water, surface water and farmland, and creates foul smell in the neighborhood. The wastewater has direct effect on urban infrastructure (Water Supply, Drainage and Road pavement structure, pollution of land, soil and ground water, and degradation of aesthetics). These all have direct effect on human health. Particularly, the increase in diseases as hepatitis, typhoid, asthma, diehreria, dysentery, skin cancer, eye and throat sore is attributed to the environmental hazards created by wastewater.

All types of waste has the potential to affect health and environment depending on the collection system used, the location where waste is generated, the waste management strategy employed and where and how it is finally disposed off. The health hazard has territorial effect and nobody is spared. This fact calls for consolidation of all stakeholders into a strong partnership and acting in an integrated and cohesive manner.

1.12 Review of Previous Plans for Enhanced Services of Sanitary Sewerage

A summary of previous recommendation is presented herewith in Table-6.

Table 6: Review of Previous Plans

SN	Projects/Authors	Recommended SS System	Treatment Method	Proposed Facilities	Achievement
1	Master Plan for WSS of Greater Kathmandu and Bhaktapur, WHO/UNDP, Binnie and Partners, 1973	- Separate storm water and sanitary sewerage system	Mechanically Aerated Stabilized Ponds	WWTP at Kodku, Dhobighat and Thimi for 2000 AD	Study
2	Second WSSP, WSSB/WB, Engineering Science Inc. 1979	Followed 1973 Master Plan	Followed 1973 Master Plan	Followed Master Plan Box culvert interceptor changed to RCC pipe	Design and Implementation
3	Water Supply and Sewerage Studies, WSSB/WB, Proctor and Redfern/East, 1984	Followed Master Plan			Review Study
4	Service Improvement and Management Support to NWSC, WB, Binnie and Partners and MULTI, 1989	Rehabilitation of System implemented under Second WSSP			Review Study
5	Greater Kathmandu drainage Master Plan, DWSS/SMEC/CEMAT, 1990	Separate Sanitary Sewers for new works	6 WWTP at Sanepa, Manohara, Bishnumati Dhobi Khola, Manohara Kodku and Nakhu	Interceptors along Tukucha, Bishnumati, Dhobi Khola, Bagmati Rivers Dhobikhola to be abandoned,	Study
6	Kathmandu Valley Urban Development Plans and Programs, DHUD/ADB, HFA/PAK-	Revision of Separate Sewerage System	Single large lagoon south of Chobhar Gorge before adopting 6	Rehabilitation of Existing Sewers and Treatment Plants, Toilet connections	Study

SN	Projects/Authors	Recommended SS System	Treatment Method	Proposed Facilities	Achievement
	POY/CEMAT 1991		WWTP		
7	Bagmati Basin Water Management Study and Investment Program, WB/Stanley Associates/ EAST, 1984	-Small separate WWTP for hospital, Army -Guheswori TP, -Dhobi Khola TP -Extension of Dhobi ghat TP and Kirtipur Pumping Station		-Rehabilitation of Existing sewer system -Improvement of sewers along Tukucha Khola -On-Site Sanitation for Kathmandu-Bhaktapur Corridor and other Rural Areas	Study
8	Urban Water Supply and Sanitation Rehabilitation Project, NWSC/WB, CES/SILT/MULTI 1992	- Rehabilitation of Dhobighat TP, Kodku TP, Kirtipur Pumping Station, - New WWTP at Chobhar before Gorge and - Trunk mains along Bagmati and Bishnumati Rivers		-Rehabilitation and extension of existing sewers, -Replacement of undersized sewers, -Construction of overflow structures, Covered channel in Tukucha	Sewerage System Master Plan options, Detailed Design, Construction abandoned at Bidding stage
9	High Powered Committee for Bagmati Area Sewerage Construction and Rehabilitation, -Guheswori WWTP HMGN/Nepalconsult, 1997	Guheswori WWTP		-Guheswori WWTP -Sewerage System in Gaurighat Area and -Tunnel to Tilganga -Road and Green Belt along Bagmati River	-Master Plan preparation -Construction and Operation of GWWTP
	-Sewer Lines along Bagmati River, HMG/CMS, 1998	12 WWTP at confluence points		-12 WWTP -Phase wise Sewer	-Study
10	Bhakatapur Development Project, HMG/GTZ, 1976	-Hanumanghat TP -Sallaghari TP	-Stabilization Ponds -Activated Sludge	Sewerage system North Main collector, South Main Collector	Construction Completed
	Rehabilitation of North and South Collector, 1991, UDLE/Welink Consultants		-	North Main collector, South Main Collector	Rehabilitation Completed
11	UN Park Development Project, HMG/ Cosmos Engineering, 1999	-Sewer Clearing -WWTP -RB Treatment	-CT -RB Treatment		Study
	Sewerage System from Shankhmul to Teku Dovan HMG/Welink, 1997	-	-Oxidation Ponds -Pollution Control	-Interceptor beyond Teku Dovan and Pumping -2 WWTP at Sudarighat and Nakhu	Study
12	Urban Water Supply Reform in KV, ADB / Metcalf & Eddy, 2000	-	-Conventional Treatment	-5 WWTP (3 existing, 1 under construction, 1 Hanumante confluence	Study
13	Urban Invironment Improvement Project, (9 Towns: Dhulikhel, Banepa, Panauti, Bharatpur, Hetauda, Ratnanagar,	Banepa: Combined Sewer and RBT	-RBTP	-7 RBTP+10 Km of combined Sewers)	Study
		Dhulikhel: Combined Sewer and RBT	-RBTP	-3 RBTP +6 Km of combined Sewers	
		Panauti: Sanitary Sewerage	-Oxidation Ponds	-2 Oxidation Ponds -5 Km of SSewer)	

SN	Projects/Authors	Recommended SS System	Treatment Method	Proposed Facilities	Achievement
	Kamalamai, Bidur, Dhadingbesi) ADB/NJS/Nepalconsult, 2002	Bharatpur: Combined Sewerage System	- Oxidation Ponds	-1 Oxidation Pond -10 Km of ComSewers)	
		Ratnanagar:Combined Sewerage System	- ?	- 1 TP (Type ?) -10 Km of ComSewers)	
		Hetauda: Combined Sewerage System	-	- 2 Oxidation Ponds -13 Km of ComSewers)	
		Bidur: Combined Sewerage System	-	-2 TP (Type ?) -1 Km of ComSewers)	
		Kamalamai:Combined Sewerage System	-	- 3 TP (Type ?) -4 Km of ComSewers)	
		Dhadingbesi:Combined Sewerage System	-	- 4 TP (Type ?) -4 Km of ComSewers)	
14	Master Plan Update for Bagmati Area Sewerage Project, HMG/ITECO Nepal, 2003	- 12 WWTP (Guheswori, Sallaghari, Madhyapur, Kirtipur, Nakhu, - Interceptor Sewers along the Rivers	- Conventional Treatment	- Design of Trunk Sewers from Tilganga to Shankhamul - Feasibility of Trunk Sewers from Shankhamul to Chovar	Study
		- Balkumari WWTP	- Trickling filter		
		- Sundharighat WWTP	- Activated Sludge	- 12 m Green Belt and 8m Road along Bagmati - Hydropark in Shankhmul-Teku Dovan Area	

ASP=Aerated Stabilized Ponds, SP=Stabilization Pond, AS=Activated Sludge, CT= Conventional Treatment, OP=Oxidation Pond

1.13 Comparison of Conventional Sewage Collection Systems

A gravity sewer system collects wastewater from properties at the lowest point within each property to ensure that it will pick up all wastewater by gravity. The gravity sewers flow downhill from the top end to the lowest point of a catchment to a pumping station or directly to a WWTP. The sewers may be categorised by type of system or material used. The comparative advantages of these systems are illustrated in Table 7 and described in Appendix-3.

Table 7A: Comparative advantages of Sewer Systems

SN	Parameters	Category of Sewerage Systems		
		Gravity	Vacuum	Pressure
1.	Previous Experience	Some	None	None
2.	Level of O&M services	Low	Medium	High
3.	Suitability for Flat Land	Low	High	High
4.	Suitability for Land with Grade	High	Medium	Low
5.	Suitability for Urban Areas	Medium	High	High
6.	Suitability for Rural Areas	High	Medium	Low
7.	Community Size	Large	Small	Small
8.	Suitability for Flood Prone and high ground water areas	Low	High	High
9.	Wet weather allowance	100%	50%	25%
10.	Treatment Plant size	Large	Medium	Small
11.	Min. Grade requirement	High	Medium	Low
12.	Feeder Pipe size	Large (>200 mm dia)	Small (32 mm dia)	Small (32 mm dia)
13.	Interceptor Pipe size	Large > 400 mm dia		Small <150 mm dia
14.	Interceptor Pipe Material	Concrete	Polythene	Polythene
15.	Interceptor Pipe Joints Leak	High	None	None
16.	Manhole Spacing	30 m interval	Eliminated	Eliminated
17.	Vacuum Pots		Every 4 Houses	
18.	In-ground Tank 630 l- 90cm dia x 2m			Every House
19.	Pump well and Grinding Pump			Every House
20.	Pumping system	Multiple, Large	Single Central, Large	Small
21.	Sanitary Condition	Anaerobic	Aerobic	Anaerobic
22.	Greenhouse Gas Emission	High	Low	Low
23.	Odour	High	Medium	Low
24.	Construction Difficulty -Excavation	High	Low	Low
25.	Construction Difficulty -Dewatering	High	Low	Low
26.	Construction Difficulty –Infiltration	High	Medium	Low
27.	Silt, Sand and solid waster entrance	High	None	Medium
28.	Mix with Drainage and Storm Water	High	None	None
29.	Energy requirement	Low	High	High
30.	Technological Complexity	Low	High	High
31.	Leakage Detection Opportunity	High	Difficult	High
32.	System Failure Opportunity	Low	High	Low
33.	Capital Cost	High	Low	Low
34.	Operational cost	Low	High	Medium
35.	Cost saving to House owners	Low	High	High

Table 7B: Comparative Advantage of Sewerage Systems

Parameters	Combined Sewer	Separate Sewer	Aerated Septic Tank
Pollution of River	High	Low	Very Low
Silt Load to Treatment Plant	High	Low	
Size of Treatment Plant	Large	Small	
Size of Sewer Lines	Large	Small	Use Existing system
No. of Sewer System	One	Two	One
Load to Pumping Station	High	Low	At Households
Investment	Low	High	Medium
Cost Effectiveness	Low	High	Medium
Skill Required	Low	Medium	High
Preservation of Environment	Low	High	High

Table 8: Comparative advantages of Sewers by Materials Used

SN	Parameters	Category of Sewerage Systems				
		Open Channel	Brick Masonry	Clay pipes	Concrete pipes	Plastic Pipes
1.	Pipe size	Large	Large	Medium	Medium	Small
2.	Depth of Excavation	Low	Large	Large	Large	Low
3.	Suitability for Pressure system	None	None	None	Medium	Large
4.	Handling and Laying	Easy	Difficult	Difficult	Difficult	Easy
5.	Leakage and Breakage	High	Medium	High	High	Low
6.	Chemical / Industrial Waste Resistance		Low	High	Low	High
7.	Trenchless installation	No	No	No	Small dia	Yes
8.	Level of Control of Inflow and Infiltration	No	Medium	Low	Low	High
9.	Level of Corrosion Resistance		Medium	High	Low	High
10.	Use for Forced Main	None	None	None	Yes	Yes
11.	Use in modern methods of rehabilitation and construction as Directional Drilling, Pipe Bursting, Slip lining					Yes
12.	Reduction of Inspection chambers		No	No	No	Yes

1.14 Comparative Advantage of WWTP

A brief comparison of various treatment plants and methods is presented in following Table 9:

Table 9: Comparative Advantage of WWTP

SN	Parameters	Types of WWTP							
		Lagoon	Aerated Lagoon	Sequential Batch Reactor	C-Tech	CWTR	Oxi-Ditch	Trick-Filter	Reed Bed
1.	Land Requirement	VH	H	L	L	L	L	L	VH
2.	Suitability for Urban Area	M	M	H	H	H	H	H	L
3.	Quality Of Influent	Combined	Combined	Separate	Separate	Separate	Separate	Separate	Separate
4.	Suitability for Large Volume of Sewage Flow	H	H	H		H	L	H	VL
5.	Suitability for Domestic Sewage	H	H	H	H	H	M	H	Pre-treatment
6.	Suitability for Industrial Sewage	Pre-treatment	Pre-treatment	Pre-treatment	Pre-treatment	Pre-treatment	H	H	Pre-treatment
7.	Treatment Process	A & AN	A					A&BF	
8.	Effluent Quality	L	L	H			M		VL
9.	Climate Suitability							Warm	
10.	Sludge Volume	H				H			
11.	Sludge Quality	L				H			
12.	Retention Time	H				L			
13.	Foul Gas Release	H	H	L					
14.	Skill Requirement	VL		H	H	H	M	M	
15.	High Tech requirement			H	H			M	
16.	Pumping Requirement							H	
17.	Chemical Use							Cl	
18.	Nuisance, odor, flies	H	H	L				L	
19.	Problems when system out of operation			H	H				
20.	Cost Effectiveness	H						H	
21.	Initial Investment	L						H	
22.	Operating Cost	L		L	L	L		H	
23.	Energy Requirement		M	M	M	M	H	H	
24.	Recommended for			Kirtipur, Madhyapur, Nakhu					

L=Large, M=Medium, H=High, VH=Very High, A=Aerobic, AN=Anaerobic, CWTR=Conventional Waste Treatment;
Source: ITECO, 2003 [18]

1.15 Failure of Sanitary Sewerage System

The sanitary sewerage system in Nepal practically failed with the withdrawal of the donor support inviting huge environmental hazard and damage to human health. The management issues of ownership, institutional capacity, operation and maintenance, and timely expansion of these systems have become major problems because of following reasons:

- Lack of adequate capacity of the responsible authorities to deal with (financial resources, agreed programs of operation and maintenance, acceptable quality of construction),
- Lack of ability to address the issues in a timely manner (For example, the rehabilitation of sewerage system in Kathmandu Valley towns are pending since 1993).
- Overlapping responsibility between Nepal Water Supply Corporation and municipalities. The sewerage systems are located within the judicial area of various municipalities but the operation and maintenance responsibility is vested on NWSC. The construction, operation and maintenance of these systems become difficult, as there is interference into the authority of the local governments. Particularly, when these systems fail to function, it becomes more problematic to the local governments rather than to the owners of the system.
- The combined sewers as brick channels are the property of the local governments but are used for sewage disposal. The responsibility for operation and maintenance is confused and overlapping.
- The expansion of sewerage network is carried out by the municipalities together with the local communities based on their demand created by unplanned urban growth. This is another interference into the jurisdiction of the authority of NWSC.
- Similarly, the roadside drainage is frequently used for sewerage disposal and interferes with the jurisdiction of the Department of Roads (?). Actually, the ownership of roadside drainage within the urban areas is also confusing.
- Lack of coordination and clear jurisdiction of authorities between the local governments and authorities are major management issues.
- There is also confusion on the use of revenue for operation and maintenance.

1.16 Method of Design and Construction of Sewer Systems

The quality of design and construction of the sewer systems has considerable effect on operation, maintenance and sustainability. Most of the sewer systems (apart from Brick Channels and Roadside drains) in Kathmandu and other cities are made of concrete pipes and are very poor in design with leaking collar joints, and constructed in open trench. Particularly, the collar joints, instead of spigot socket joints, are not properly made; lines and levels are not properly maintained; post construction clearance and water tightness tests were not carried out. The construction and maintenance of these sewers require disruption of the road surface and create disturbance to traffic and urban life. All sewers above 150 mm are made of concrete pipes or made in brick whereas smaller pipes below 150 mm are made of HDPE or PVC. Contrary to this, there is need for introducing new method of sewer construction using “No Dig” technology with micro-tunnelling could be next direction of construction since it will substantially reduce the cost and time of construction (Appendix 3). Sewers from 150 mm dia to 3000 mm could be laid using appropriate Mini Tunnel Boring Machines (MTBM). The technology is used for laying concrete, steel and plastic pipes without digging open trench.

1.17 Operation and Maintenance of the Existing Sewer Systems

The operation and maintenance difficulties of sewer systems are the results of quality of design, construction of the sewer systems, management ability of the authorities and behavior of the users. The major problems and issues that affect the O&M of sewerage system are summarized as follows:

- Poor Quality of Sewerage System design
  - Use of undersized pipelines (e.g. DN 150 against international standard of DN 200)
  - Construction of Sanitary Sewer lines without proper development of Storm water sewers
  - Extension of Sewer lines without proper survey, investigation and design
  - Intermingling of Sanitary Sewerage system by new extended combined sewers
  - Location of water supply lines in close proximity with sewerage system
- Poor Quality of Construction:
  - Lack of fundamental procedures of functional tests prior to the acceptance as proper inspection of the sewer lines during construction by mirror test and water-tightness tests
  - Lack of choice of appropriate pipe joints (Spigot socket joint or Collar Joint)
  - Lack of ability to place in proper lines and levels
- Lack of responsible institutional arrangement for O&M
  - Lack of proper responsible organization and adequate capacity
  - Overlap of responsibility between NWSC and Municipalities
  - Lack of proper training to O&M Staff
  - Lack of Rules and regulation to prevent unwarranted activities and imposing penalty to defaulters
  - Lack of monitoring, surveillance and audit of O&M performance
  - Lack of rules for disposal of wastewater from workshops, food processing units and industries without pretreatment
- Lack of O&M procedures
  - Lack of proper records of sanitary sewerage system development and maintenance
  - Lack of approach for preventing of roots and infiltration (and exfiltration). Cutting tree roots and cleaning the soil from sewer lines are expensive and difficult cleaning process.
  - Lack of procedures for prevention of disposal of construction debris, garbage, inflammable liquids, corrosive materials, and dead animals
- Lack of Environmental Management System
  - Lack of methods to ban multiple handling of sludge from sewer lines
  - Lack of methods to ban obstruction of flow with soil deposit for abstracting black water for irrigating the nearby farmland
- Lack of Community Awareness and understanding that:
  - Wastewater shall be connected to sanitary sewerage system
  - Dumping toxic or harmful pollutants, and solid waste into the sewer shall be avoided
  - Discharge of drainage water and storm water into the sewerage system is not permitted. This, however, cannot be guaranteed.
  - Encroachment of Drainage and Sewerage systems will disturb the functioning of these systems.

1.18 Operation and Maintenance of Treatment Facilities

The determination of efficiency and economy of operation of treatment facilities require continuous studies. Flow measurement, influent and effluent sampling would be the main tasks apart from establishing the evaluation procedures and analysis.

1.19 Initiatives by Informal Sector

The informal sector took some initiatives in operation and maintenance of septic tanks by recovery of sludge from the septic tanks, transferring and disposal into Sludge treatment facilities of municipalities or in the Sewage Treatment Plants or rivers. The operation and maintenance of sewerage network through outsourcing to the private sector would be a change in the practice and the municipalities could be relieved from the difficult job and they could focus on overseeing and monitoring of the performance of the private sector. The private sector could mobilize maintenance equipment, trained manpower and resources as the demand of the job. One of the major tasks of operation and maintenance of sewer lines and treatment plants are to carry out following Services:

- Inventory and condition assessment
- Sewer system evaluation surveys
- Sewer House connection Inventory surveys
- Removing Blockage by Roding, Sewer Jetting and Root
- Pipeline Inspection and Locating of Appetunances
- Leakage Test
- Planned Maintenance Programs
- Removal of Sludge, weed and Reed Plants

A list of Sewerage Services suitable for outsourcing to the private sector is provided in Appendix-4.

1.20 Effluent Quality

There is no effluent quality specified by NWSP of Nepal. However, following effluent quality standard established by US EPA designed to meet the public health standards may be referred.

Table 10: Effluent Quality Standards (US EPA)

SN	Parameters	Values of effluent sample collected in 30 consecutive days	Values of effluent sample collected in 30 consecutive days	Values of effluent sample collected in 7 consecutive days
1	BOD (5 day)	Arithmetic Mean < 30 mg/L	Arithmetic Mean < 15% of values of influent in the same period	Arithmetic Mean <45 mg/L
2	Suspended Solids	< 30 mg/L	< 15% of values of influent in the same period	<45 mg/L
3	Fecal Coliform Bacteria	Geometric Mean < 200/100ml		Geometric Mean < 400/100ml
4	pH	6-9		

1.21 Disposal and Reuse of treated effluent

The treated effluent could be disposed of or reused for various purposes that includes:

- Disposal into river – This will allow for further purification of the treated wastewater by natural process. If the treated effluent were reused for drinking water supply, it would be advisable to treat with chlorination prior to disposal.
- Irrigation Use – The crops produced with such wastewater are used for human consumption. The treated water could be chlorinated and meet the effluent standards. The wastewater so treated shall be free from pathogens.
- Aquaculture – If the fish or other aquatic creatures raised with the use of treated effluent are subject to human consumption, then they should not contain pathogens. So the effluent should be chlorinated.
- Hydroponics Gardening (Reed bed treatment) – The advantage of hydroponics gardening is that the crops grow very fast and the crops are uniform because of the controlled conditions. But the crops shall be free from pathogens and the effluent used for such gardening shall be chlorinated.
- Recycling for Industrial use – The treated effluent may use for industrial purposes as the fresh water
- Ground water recharge – If the treated effluent is used in water shortage areas for recharging the ground water, then the effluent should be chlorination in order to make it pathogen free. Otherwise, colonies of bacteria will fill the voids between the soil grains and reduce the effectiveness of recharge process.
- Municipal water supply – The effluent from the treatment plants is some times diverted to the municipal water supply in water short areas after chlorination. However, such activities shall be carried out with caution otherwise it will always be controversial.

1.22 Sludge Disposal

- Sanitary Landfill – Sanitary land fill sites are often preferred disposal technique for sewage solid disposal. Dewatered, dried, or incinerated sludge may be disposed of in the landfill sites directly where as wet sludge shall be carefully handled and spread in the working space and mixed with other solid waste. Disease transmission, odor, heavy metal concentration, biological, physical and chemical processes must be considered before disposing in a landfill site.
- Fertilizer and Soil Conditioner – Sludge is not a particulalry good fertilizer, but it has some value as soil conditioner. It's effeectiveness depends upon with nitrogen removal by plants, and concentration of metals, plastics, sand and silt in the sludge.
- Landscaping – Sludge is used as fill material for lanscaping with careful layering of the fill material and proper provison of drainage.
- Recovery of combustible gases – The anerobic digestion of sludge may result in formation of combustible gases as hydrogen sulphide and methane which may be used for cooking and lighteting.

Chapter II

Review of Policies, Legislation and Development Plans

2.1 The Governmental and Sector Policy

With realization of the facts, the Government of Nepal (the then His Majesty's Government of Nepal) formulated and enacted sector policies and several legislative measures highlighted below.

2.2 The Constitution of Nepal, 1991

The Article 26(4) proclaims: "The state shall give priority to the protection of the environment and also to prevent its further damage due to the physical development activities by increasing the awareness of the general public about environmental cleanliness and the State shall also arrange for the specific protection of rare wildlife, forest and vegetation". Article 88 (2) has conferred a right where any person can directly move an appeal to the Supreme Court on any issue of public interest or importance, including environmental issues".

2.3 National Water Supply Sector Policy, 1998

The National Water Supply Sector Policy promulgated by the government in 1998 has defined following principal objectives for water supply and sanitation programs:

- To provide safe, convenient and adequate water supply with sanitation as an integral component to all the Nepalese population,
- To reduce the incidence of water related diseases, and
- To lessen sufferings of women and children to collect and carry water.

2.4 RWSS National Policy and Strategy 2004

National Policy

His Majesty's Government of Nepal is committed to provide the basic needs of water supply to all its citizens within 2017 A.D. In order to cover all the sectors of the population a working policy applicable and enforceable was prepared. As the health and hygiene of the population at large dependant on the quality of the drinking water supply, the sanitary and hygiene part also is incorporated under this policy. The Primary objectives of the Policy are:

- To provide safe, accessible and adequate water supply with sanitation facility to all the citizens on priority basis especially targeted to the backward people and ethnic groups.
- To reduce incidence of water borne diseases and protect the population from the health impact of the diseases.
- To utilize the time and labour of woman, men and children saved from carrying water in productive works.

National Strategy

Within the frameworks of the Policy Guidelines, Rural Water Supply and Sanitation Strategy 2004, and Sectoral Action Plan 2004 have been prepared. This strategy and Action Plan will

streamline the implementation process in this sector. The Community Based Water Supply and Sanitation Sector Project has undertaken the directives according to the policy and strategy with refined support services providers (NGOs, CBOs, and PSOs) through Water Supply and Sanitation Team (WSST) and DDC at district level, and Project Management Consultant at PMU in central level.

2.5 Draft Policy of Waste Water Management, 2006

The Government of Nepal is currently drafting a policy on Waste Water Management that will provide guidelines for project preparation, planning, [survey, investigation, design, construction, operation and maintenance, financing, partnership, community mobilization], repair and maintenance, and delineation of role and responsibilities of various stakeholders. The proposed primary objectives of the Policy are: a) Improving Sanitary conditions of the environment [water courses] by compliance to standards established by a competent agency, b) reducing morbidity and mortality rate related to wastewater system, c) facilitating construction and management of [separate] storm and sanitary sewerage systems, d) Improving sanitary condition of local streams, rivers, lakes and ponds, [and other water sources as springs, spouts, water supply lines, reservoirs] to safe reusable conditions as established by a competent authority, e) establishing coordination and integrated approach among the stakeholders for planning, construction, operation, maintenance, and management of sewerage system, f) establishing relation [partnership] with the Government and Private Institutions [Sector] for research and development of appropriate technologies for wastewater disposal and management, and [financing], g) developing mechanism for building awareness among the stakeholders and beneficiaries.

The Policy restricts disposal of wastewater to nature or open space without treatment to a safer level for living being and environment.

2.6 Integrated policy for both sanitation and water supply, 2001

The MPPW promulgated the Nepal National Sanitation Policy and Guidelines for Planning and Implementation of National Sanitation Policy, 1994 and the National Water Supply Sector Policy (NWSSP), 1998. The NNSPG was later on amended in 2001.The stated objectives of both NNSPG and NWSSP are focused on “Selection of projects on the merits of socio-economic and technical feasibility with special consideration of local hardships, felt needs of the communities and willingness to contribute on the capital costs of the project, and ensuring accountability and involvement of users with initiation, implementation and O&M of WSSP ”. The main policy strategies include 1) Reduction of morbidity and mortality due to water borne diseases and lack of environmental sanitation and hygiene 2) Bringing attitudinal and behavior changes, and 3) Integration of water supply and sanitation programs.

2.7 National Guidelines for Hygiene and Sanitation Promotion –2005

The Policy and Working Policies related to the Sanitation are summarized in following points:

- Mutual coordination among the agencies involved in drinking water and sanitation sector will be made functional and effective under the active role of the **National Drinking Water and Sanitation committee**. At the ministry level, coordination among the government, non-government and private sector as well as other agencies involved in drinking water supply will be established to enhance project effectiveness.

- The construction of sewerage drainage system with filtration plant under the active involvement of consumers' group for unpolluted urban environment will be encouraged. The consumers will be motivated to construct private toilets with septic tanks in the areas where there is no sewerage drainage system. Private sector will be involved for institutional development in collecting and processing of night soil of septic tanks to produce agriculture manures. Necessary laws will be enacted and enforced to discourage the tendency of polluting clean and pure environment by discharge of sewerage drainage in the rainwater drainage, surface water drainage, river and streams.
- Prohibition of drainage [Sewerage] connection to the rivers and encouragement to the local authorities for establishment of Sewage TP.

2.8 Water Resources Strategy and National Water Plan (1997-2027):

Nepal's population is expected to double in the next 30 years and the demand for water from all sectors as water supply, irrigation, industry, recreational industry, and Hydropower will also be intensified. Therefore, to manage the Water Resources in a defined and planned ways, the Water Resources Strategy and National Water Plan have been prepared under Nepal Irrigation Sector Project. WRS has already been approved by GON, and the National Water Plan was approved by the Government in September 2005 and envisaged to invest an amount of NPR 1,218 Billion. A brief of the strategy on Water Supply and Sanitation Sector is presented in Table 11.

The National Water Supply and Sanitation Policy has adopted a two level approach for the development of the sector with paramount emphasis on sustainability of services with a 20-year vision, which are: (i) to achieve additional coverage for population without access to water supply and sanitation, and (ii) to improve the levels of service for population already availing these services.

Accordingly, the following long-term targets have been set in Table 11.

Table 11: Long term plan for provision of Basic Sanitation

SN	Development Plan	End Year	Basic Sanitation as % of National Population	Access to safe water Supply in % of Population	
				Basic Services	Good Services
1	Tenth	2007	60		
2	Eleventh	2012	80	85	40
3	Twelfth Plan	2017	100	100	60
4	Fourteenth	2027	100	100	85

2.9 Drinking Water Corporation Act, 1989

The Act mentions the expediency of maintaining public welfare and health by distributing pure drinking water and to make proper arrangement for drainage [**Sewerage**] systems. Section 5 of the Act imposes rights and duties of the Corporation to prevent pollution in drinking water systems.

2.10 Environmental Protection Act 1997

EPA 1997 requires all projects to review and carry out environmental studies for all proposed projects. The basic provisions of the Act are as follows:

- A proponent shall submit a proposal for implementation along with a report on Initial Environmental Examination and Environmental Impact Assessment of the proposal as prescribed for approval by the concerned agency
- Prohibition on implementation of proposals without approval from the concerned agency or the Ministry.

2.11 Local Self-Governance Act and Regulation, 1999

The Part 2, Part 3 and Part 4 of the Act have given ample power to the local bodies (Village Development Committees, Municipalities and District Development Committees respectively) in relation to the environmental and sanitation issues.

The Act has made very cursory provision for arrangement for street cleaning, disposal of wastes, dirt and rotten materials, and **to make arrangements to encourage the inhabitants of the Ward for maintaining sanitation** is given to the Ward Committee under Village Development Committee and Municipalities.

The local bodies are given authority for preparation of programmes on primary health, education, sanitation, and collection, transportation, disposal of wastes and garbage in the village development area. Accordingly, the Local Self-Governance Regulation has prescribed the procedures for formulation of plans, programmes and resource maps and procedures for their implementation.

2.12 Public Private Partnership Policy, 2060 (2004) and Guidelines, 2061 (2005)

The two major factors upon which the concept of PPP is based are: **Value of Money and Project Structure**. Based on the above broader framework, The Government of Nepal has shown increased interest in involving the private sector in upgrading the level of services locally and included the concept of Public-Private Partnership (PPP) as part of the 10^{th} plan. To create an enabling environment and introduce PPP as a viable development alternative, HMGN/UNDP launched the Public-Private Partnership for Urban Environment (PPPUE) in March 2002-2007. The development objective of PPPUE is to increase the access of the urban citizens to basic services, and therewith, to contribute to the creation of a healthy environment and the improvement of living conditions in the urban and semi-urban areas, by promotion of partnerships between public and private sectors for the sustainable provision of urban services.

The PPP Policy provides the Framework for Private Sector to provide basic services. Key features are provision of Central Coordination Unit, Partnership Models for various projects and programs, Committee of Representatives and provides conditions of joint ownership of assets by the partners. The PPP Guidelines provides the Framework for implementation including scope, principles and priorities, institutional arrangement, project identification and project clearance procedures**.**

2.13 Tenth Plan (2002-2007)

The Tenth Plan has adopted following objectives and quantified targets in sanitation:
Objectives:

- Provide appropriate sanitation facilities in urban and rural areas by increasing peoples' awareness

- Assist in reducing child mortality rate by controlling water borne diseases and water induced diseases and there by helping to increase income generation through opportunity to utilize saved labour from illness

Quantitative Target:

- Sanitation facility will be provided to 7.421 million people including 5.613 million from rural and 1.808 million from urban areas by motivating the households to construct private toilets. Public awareness on personal hygiene and sanitation will be increased through mass publicity and training programs within the Tenth Plan period.

Strategy

- Sanitation program will be made as an integral part of the drinking water supply project. In the urban areas where population density is high, public awareness in sanitation will be raised, and [Separate] drainage [and] sewerage system will be constructed with community participation. In other places emphasis will be given to construct public toilets.
- The **Sewerage drain construction program** in the urban areas and district headquarters will be implemented based on local needs assessment to minimize the adverse impact resulted by growing urbanization and high population density on urban environment. Based on availability of financial resources, the plan has made provision to construct sewerage drainage system with the treatment plant in few other towns of the country.

2.14 Melamchi Water Supply Project

The Project includes rehabilitation of the existing sewerage and surface drainage system of the Kathmandu Valley. It further states that the limited sewerage drainage facilities existed in few places at present will be gradually extended. The existing non-functioning sewerage treatment plants/stations will bring into operation by rehabilitating and renovating them along with the construction of new drainage system, make the rapidly polluting rivers and rivulets of the Kathmandu Valley pollution free.

2.15 Kyoto Protocol

The Kyoto Protocol, ratified by Nepal by accession on Dec 5, 2005, is known as Framework Convention on Climate Change. It has had focused on following points related to UWM:

- Increased use of new and renewable forms of energy, use of CO_2 reduction technology and environmentally sound technologies
- Established quota for carbon emissions for each country with the objective is to bring down the emissions in industrial countries to 8 per cent below the level of 1990, by 2012.
- Reduction of methane emissions through recovery and use in waste management
- Provisions made for Transfer of Carbon Emission Credits (CEC)
- Provision for Clean Development Mechanism (CDM) funds for utilizing CEC
- Imposing fine for exceeding the quota of carbon emissions, by a unit, is EUR 40 a ton
- Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments;
- Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of **greenhouse gases** not controlled by the Montreal Protocol;

- Measures to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector;
- Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy.

The Protocol focuses on limitations of solid waste disposal on land, wastewater handling, and waste incineration.

2.16 Millennium Development Goals Agenda 21

The Millennium Development Goals have focused on waste management issues very strongly, and particularly, Chapter 21 deals with environmentally sound management of **sewage-related issues**.

2.17 International Standard Organization 14001

ISO promotes the development and implementation of voluntary international standards, both for particular products and for environmental management issues. ISO 14000 refers to a series of voluntary standards in the environmental field including ISO 14001 related to Environmental Management Systems (EMS) and other standards in fields such as environmental auditing, environmental performance evaluation, environmental labeling, and life-cycle assessment. The ISO 14001 standard requires that a municipality, community or organization put in place and implement a series of practices and procedures that, when taken together, result in an environmental management system. ISO 14001 is not a technical standard and as such does not in any way replace technical requirements embodied in statutes or regulations. It also does not set prescribed standards of performance for organizations. The major requirements of an EMS under ISO 14001 include: A policy statement at corporate level that includes commitments to prevention of pollution, continual improvement of the EMS leading to improvements in overall environmental performance, and compliance with all applicable statutory and regulatory requirements.

2.18 Other Important Policies, Regulations and Conventions

Some of the other important Legislation, Regulations and Conventions are listed below. The major provisions of these policies are summarized in BLN, 2005[27]:

- Industrial Policy Act, 1992
- Town Development Act,1988
- Water Resources Act, 1992
- Public Infrastructure (BOT) Policy, 2000 (Construction and Operation)
- Private Investment in Construction and Operation of Infrastructure Ordinance, 2003
- Procurement Act, 2004 (Draft)
- Foreign Investment and Transfer of Technology Act,
- Child Labour Laws
- Minimum Age Convention 138 (C138), 1973
- Worst Forms of Child Labor Convention 182 (C182), 1999
- Basal Convention 1989
- Rotterdam Convention 1998
- Stockholm Convention, 2001

2.19 Use of EMS by Municipalities

Municipalities and Business houses typically oversee a number of activities, facilities and operations. EMSs can be used as a framework to help these operations to improve their environmental performance and make greater use of pollution prevention approaches. Use of the standard by municipalities and businesses is not well established at this point, but its use will help for pollution prevention and production of cleaner production, cost saving and enhance public image.

2.20 Ownership of River Systems

The river systems in many urban areas are permanently polluted with wastewater discharge and solid waste dump that destroyed aquatic life and contaminated the ground water. There are several reasons for pollution of river systems. Some of the reasons are as described herewith:

- Lack of ownership of the rivers. None of the institutions are exclusively responsible by Law for river basin conservation.
- Rivers are the boundary of two adjacent municipalities and none of them are exclusively responsible for their care, though LSGA authorised them for conservation of the rivers;
- Illegal encroachment of River Basin as banks and bed for private use;
- Misuse of River Basin for abstraction of sand without due consideration to the river regime;
- Civil Societies are not properly empowered (Save the Bagmati Campaign is exhausted of its mission) and advocacy is not recognised.

It is suggested that the ownership of river systems and nature shall be attributed to an Exclusive Agency who will be responsible for conservation in line with concept of King Mahendra Trust for Nature conservation.

2.21 Environmental Pollution Not Priority Issues

The problem of environmental pollution from industries or urban sectors was not a priority issue of the government in its initial phases of development planning. Main focuses of development in the early planning stages are seen revolving around development of infrastructures, human resources and productivity. It is only after the Sixth Plan (1980-85) that the issue of environmental pollution and its social costs has been realized at least in the policy level. By the turn of Eight Plan (1992-1997), environmental pollution has been one of the key priority policy concerns.

2.22 Review of International Practices

The review of international practices in Sanitation was carried out for certain selected countries as India, China, Japan, USA and Switzerland and compared with the status in Nepal. The practices adopted could be attributed as the reflection of the development status and image of the countries. A brief summary of international practices applied is given in Table 2-1.

In respect of wastewater, India, Nepal and China are basically disposing the wastewater in the nature whereas the developed countries practicing high-tech methods for prevention of water pollution and recycling wastewater.

Table 12: International Practice in WWM

Countries	Waste Water	Source
India	70% Untreated	MOFE/UNEP
China	70% Untreated	ADB/OECD
Japan	30% Untreated, Recycle	MOE
USA	Clean Water Act, Recycle	Constitution, USEPA
Switzerland	High Tech Treatment	SAEFL
Nepal	90% Untreated	MOPE

Chapter III

Review of Good Practices

3.1 Current Good Practices in Sanitary Sewerage Management

The review of the current best practices in Wastewater Management is carried out and presented in Table 3-1. The wastewater treatment is found to be given least priority and is grossly neglected in comparision to water supply. Three plants remained defunct for various reasons whereas wetland waste water treatment (Reedbed) plants are grossly found inefficient because of incomplete desgn and construction. The Reed bed treatment plant is not functioning during monsoon period since there is not system to retain the rain water and waste water is over flooded without treatment, the pipe systems and gravel filter media is chocked with accumulated sludge, the reed bed plants do not absorb other elements (Sulphur, heavy metals) than NPK. Waster water remains polluted. More rationale of the installed plants is required to seek and operational aspects required more serious consideration. This system shall not be promoted without further investigation and adequate technical justification.

Table 13: Best Practices in Waste Water

Current Best Practices	Magnitude	Remarks
Waste Water Treatment Plants in Kathmandu (Guheswori – 16.4 Mld, Dhobighat 15 Mld, Kodku 1.1 Mld,)	3 Nos (32.5 Mld)	Dhobighat Plant Defunct, Guheswori receives mixed waste
Waste Water Treatment Plants in Bhaktapur (Sallaghari – 2.4 Mld, Hanumanghat 0.2 Mld)	2 Nos (2.6 Mld)	Sallaghari and Hanumanghat Plants Defunct
Waste Water Treatment Plants in Hetauda Industrial District (1 Mld)	1 No (1 Mld)	
Reed Bed Plants (Dhulikhel 2 Nos, Thimi 1 No, Pokhara 1 No,	12 Nos	Overflow in Monsoon, Filter and Piping system choked, Sludge Management and Pathogen control not carried out
Environmental labeling of Export Oriented Industries		FINNIDA Supported
Shankhu Experience in preservation of Shalinadi		Carpet Industries are restricted in upstream of Shalinadighat
Private sector initiated Sludge Removal services from Septic Tanks		

Source: CES/Multi 1993, ENPHO, HIDM, COWI

3.2 Save the Bagmati Campaign

Save the Bagmati Campaign was launched in 1991 by the pioneer of the campaign Mr. Huta Ram Vaidya with the aims to restore the state of the river into its original natural environment of 1950s. The river in recent decades has suffered from abuse by the municipalities and the government through over-extraction at Sudarijal for supplying drinking water to Kathmandu Valley Towns, damming for irrigation, disposal of sewerage effluent at several points along

the river, dumping of solid waste along its banks, indiscriminate sand mining from its bed, encroachment of its banks and left over land by unidentified squatters settlers groups.

The campaign mainly focused on mobilisation of citizens, local groups, civil societies and advocated for a central high-powered organisation that could coordinate the efforts for control of pollution and restoring the aesthetics. The Campaign implemented small scale cleaning campaigns, training to local groups active in the area, encouraging neighbourhood watch schemes. The construction of Wastewater Treatment Plant at Guheswori could be attributed as the commendable achievement of the Campaign.

3.3 UN Park Project

The UN Park project is developed with the objective to restore the lost glory of Bagmati River Basin within conservation and development of Bagmati River Corridor, Bishnumati River Corridor, Dhobi Khola Basin, particularly along the city core area with a large number of historic monuments through developing recreational parks, green belts and sewerage system improvement with construction of sewage treatment plants. The project is currently jeopardized by the controversies among various interest groups over the ownership for use of land leftover by the river. Whereas some groups advocated that building parks and restaurants in the riverbanks could undermine the Bagmati River, the others consider it will be helpful for the river conservation and prevention of encroachment.

3.4 Bagmati Area Sewerage Improvement Project

BASIP under High-Powered Committee for the Bagmati Area Sewerage Improvement constructed and operating the Guheswori Wastewater Treatment Plant with diverted flow from sewage collected from Gokarna and Chabihal Area. The Committee has objectives to improve the quality of water in the Bagmati River basin through construction of trunk sewers along Bagmati River downstream of Guheswori with 12 WWTP at the confluence points and phase wise construction of sewer system, implementation of green belt and road along Bagmati river.

3.5 Services for Sludge Removal from Septic Tank

This is the only service provided by informal private sector for removal of sludge from septic tanks from the private residences. The sludge from septic tanks is collected in the mobile tanks and dispose off at Teku wetland plant or disposed in the rivers.

Chapter IV

Review of Past Failures

4.1 Commitment Failures

The commitment of the Government and the municipalities to provide clean and healthy environment has been grossly ignored and efforts required were differed over time for decades. In case of wastewater management in Kathmandu Valley is delayed over 30 years, and the Government and the Municipalities do not take responsibility. There is no easy way or magic that can help wastewater management without proper efforts. The decision makers and authorities realize only those advises that are compatible to their desire or interest or what they understand. The myth that Nepal cannot afford separate sewerage system has destroyed all systems of Sanitary Sewerage and contamination of river systems and destroyed aquatic life.

4.2 Policy Failures

Several Policy Decisions, Plans and Program were not followed up and not implemented as envisaged by the plans. Though the policies have had ample provisions requiring proper WWM, the political will and commitment for implementation of the plans and programs remained very weak. Major wastewater treatment plants and sewerage systems remained defunct from the time of construction in 1980. Because of the continuous failure in implementation, the World Bank gradually pulled back from being involved in WSSS in Kathmandu Valley. Further, the bundling of the Sewerage Treatment Plants of Kathmandu Valley with the Melamchi Project also proved to be disastrous since the Melamchi Project itself remained unsuccessful. ADB's ability to nominate a Private Sector Management Contractor remains in question. The Donor's involvement or noninvolvement in WWS proved of little advantage for Kathmandu Valley so far.

4.3 Legislation and Institutional Failures

The WWM remained in the domain of various institutions from various Ministries to Municipalities. The role and responsibilities of DWSS, NWSC, VDC, DDC, Municipalities and other stakeholders are overlapping and confused. There were severe gap and overlap. The municipalities in Kathmandu and Lalitpur tamper the sanitary sewerage system with connection of new pipelines and connection of storm water drainage.

4.4 Failure to recognize WWM as an Infrastructure

The WWM was never recognised in par with Water Supply, Electricity, Telecommunication, Roads and Bridges, and Industries, and is given least priority. Though the plans and programs made ample provisions, the issues associated with WWM are dealt at sporadic level and shadowed by the other general environmental issues and development plans.

4.5 Neglect to Environmental Guidelines

The Agency-managed SWM systems suffered with lack of adequate environmental and social consideration explicitly expressed in the policy documents. None of the wastewater projects

were subject to environmental impact assessment and environmental audit. The environmental and health hazard created by the mismanagement of wastewater is well understood, but apparently no body takes responsibility. The quality of water in Bagmati river is indicated in Table 14.

Table 14: Water Quality in Bagmati River

SN	Location	COD, mg/l	BOD, mg/l	DO, mg/l	TSS, mg/l	Remarks/Source of data
1.	Bagmati near Sundarijal	25				
2.	Bagmati at Aryaghat	37				After treatment at Guheswori Plant
3.	Bagmati at Tilganga	455				
4.	Bagmati at Minbhawan	423			**57-732**	
5.	Bagmati at Shankhmul	**10-52**	**9-48**	**<1-6.2**	**35-2381**	Cemat/Metcalf Eddy 1999
6.	Bagmati at Sundarighat	**228**	**51**	**5.3**	**-**	Cemat/Metcalf Eddy 1999
7.	Bagmati at Khokana	**7-332**	**4-28**	**<1-7.4**	**0-223**	Cemat/Metcalf Eddy 1999
8.	Bagmati at Chobhar	454				
9.	Bagmati at Gaur	25				

Source: CES/Multi 1992, ENPHO 2003,

4.6 No exclusive and dedicated organization

Actually, no exclusive and dedicated organisation at National and local level exists to deal with the issues of WWM in a comprehensive and integrated manner. There are no independent institutions responsible for monitoring of Environmental Performance, Environmental Surveillance, and Audit. Practically, there are no Civil Societies capable and properly empowered to advocate for the preservation of the nature, environment and human health compared to Human Rights Commission.

Similarly, the Government and the municipalities including the donor communities failed to fulfil their international commitments including Environmental Protection commitments and continued to implement the reforms required.

4.7 Lack of Long Term Vision and Goals

Lack of long term vision and goals has had its toll on WWM sector. The hazards created today in Nepal are the direct result of such a deficiency. Lack of ability to understand that long-term vision shall start from today is a strong failure in itself. It is highly recognized that the Government and Municipalities had always given attention on short-term solutions only.

4.8 Abuse of River Corridors

The Bagmati, Bishnumati and Manohara River corridors from Gokarna to Chobhar are today turned to dumping yards with garbage disposed and wastewater discharged from the cities of Kathmandu Valley. The river system in Kathmandu Valley is now permanently polluted with wastewater and solid waste dumping. The areas along the rivers are filthy with bad smell,

infested with birds of pray and rodents. The ground water remains permanently contaminated forever. The organic matters in the dumping strips generate methane gas, which will be released continuously for long period over 20 years. There is constant threat that the methane gas accumulated within the dumped mass may explode some time. All aquatic life in these rivers ceased to exist and the wild life of the Kathmandu Valley, for instance the monkeys in Pashupati area that depend on the river water for livelihood, is infected with various diseases and waiting for total extinction. Many river systems near the urban areas have similar fate. The rivers will remain contaminated forever. This is one of the sources of spread of water borne diseases in Kathmandu Valley.

4.9 Diversion of River Flow

The natural river flow in Bagmati, Bishnumati, Manohara, Hanumante, Kodku rivers are diverted for use for drinking water or irrigation without leaving natural water for maintaining natural regime of the rivers. This has deprived the availability of natural media for dilution of pollutants. The general principle of "Dilution is the solution of Pollution" was not followed. The right of the River (and Nature) was not recognized any more since there is no organizations that own the river systems.

4.10 Diversion of Resources

NWSC collects certain revenue for wastewater managmenet along with the water tariff at the rate of 30% of water tariff. This amount is diverted for administrative and staff costs and only partially utilized for developing capacity for WWM.

4.11 Contamination of selected urban areas in Dhobi Khola basin and Duwakot Area

It is assumed that 95% of the wastewater generated in Nepal is disposed of into the Nature in the rivers, ponds or underground through septic tanks. This is a prime source of spread of water borne diseases, environmental damage and contamination of the drinking water sources. Particularly, the Dhobi Khola shallow wellfield (dug wells and swallow tube wells) are contaminated beyond treatment and discarded by NWSC as water source. Similarly, the whole area of Duwakot is now permnently polluted with Septic Tank discharge to underground making whole area smell filthy. The water quality of dug wells need to be checked for contamination.

4.12 Defunct Wastewater Plants

The wastewater plants at Dhobighat (15 Mld capacity), Sallaghari (2.4 MLd) and Hanumanghat (0.2 Mld) are defunct since 1995 with wastewater being disposed of into the rivers without treatment. These treatment plants awaiting for major rehabilitation remained defunct since they are bundled with the Melamchi Water Supply Project making it much more complicated issue. These plants are getting more dilapidated with the lapse of time and facing strong pressure from various sectors and in danger of being used for some other purpose. Huge investments made in these plants remain idle for such a long time.

4.13 Poor Quality Construction

The collector piped sewerage systems in Kathmandu, Lalitpur and Bhaktapur are mostly leaking due to poor construction and mixed up with the surface water drainage. The sewer

system suffered from undersize design with sewer as small as dia 150 mm (compared to min. 200mm dia adopted by European and USA codes); use of inappropriate pipe joint system with collar joints (Difficult to fix in position when excavaion trench are narrow and deep).

4.14 Choice of Sanitary Sewerage System and Appropriate Technology

The choice of Sanitary System since 1973 was based on separate system of sanitary sewerage and storm water drainage. The reasons were obvious (Refer…). The separate sanitary sewerage system developed during the Second WSS Project in Greater Kathmandu required special attention and care preventing inflow of surface water drainage and solid waste. For several reasons, this priciple was not maintained as a result the sanitary sewerage system was overloaded with surface drainage and sand and silt factor that caused damage to the pumping station at Sundarighat and WW Treatment Plants at Dhobighat and Sallaghari. Similarly, the sewerage system in Bhakapur suffered with the storm water overload together with solid waste, sand and silt factor load, which cause disruption to the multistage online pumping station in the main interceptor sewers. Bhaktapur sewerage system being design for combined system inherited the the surface drainage load and carried a lot of silt and sand that prematuarly overloaded the Hanumante Treatment Plant.

At the same time, the surface water drainage systems are gradually converting to combined sewerage system that further contaminate the river system.

4.15 Weakness of Reed Bed Treatment Plants

The Reed Bed Waste Water Treatment Plants (RBP) are promoted as an alternative to the institutional failure of Biological Lagoon Wastewater Treatment Plants in Kathmandu. These wetland plants are probably incomplete in design since they were used as secondary treatment whereas fundamentally they are meant for treatment of sludge from wastewater treatment plants as tertiary treatment prior to disposal of the effluent to Nature or recycling. The Reed Bed plants in use are considered to have following deficiencies:

- Reed Plants are efficient in initial period, block effluent flow as roots grow, NPK absorption becomes low as Reeds mature. Other chemicals as Sulfur and heavy metals remain in the effluent and carried down stream. The Reed leaves and roots are nuisance and require special treatment since it is not used commercially.
- Due to the lack of primary and secondary ponds for appropriate and adequate desilting, settling, anaerobic and aerobic process of sewage digestion, the filter media and the pipe systems in RBP are chocked and require replacement in very short time
- The detention period of effluent is inadequate for settling of suspended solid
- During the monsoon period, the filter media and the reed beds are full with rainwater and the wastewater overflows to nature without treatment,
- Pathogen carriage to down stream land drainage is not monitored and controlled.
- Current studies reported on BOD and COD controls, but sludge management and Pathogen monitoring are not reported.
- Wetland requires large pool of water for further oxidation and solar radiation (photosynthesis), place for birds and fish to play, and growth of weed which is not provided in Reed Bed Plants
- Worldwide experience in application of Reed Bed Plants is limited only at tertiary level compared to the current practice of using in Primary/Secondary level in Nepal.

The current Reed bed plants shall be considered as pilot projects and subject to continuous research and study under Academic supervision. It is time for conducting a performance evaluation study and carry out Technical Audit of the implemented projects in order to derived in-depth lessons for replication of good practices and use in next projects and avoid weaknesses of previous projects.

The Reed Bed Treatment technology is in pilot stage of development and requires further research.
This situation requires reconsideration of Reed Bed Plants Technology and should be thoroughly discussed and their economic sustainability should be proved before further application of the Technology.

4.16 Indoor Air Pollution

Poor indoor sanitation condition is one of the source of indoor air pollution contributing to serious health hazard, particulalry the lack of proper plumbing system (provision of floor traps, vent pipes extending to roof top, ventilation of rooms that take the faul air to roof top) and location of toilets near stair and corridors. This requires development of a standard manual and designs for indoor sanitation planning.

4.17 Lack of PPP in WWM

Wastewater Management is considered as the business of the Central Government and Municipalities only and particular regard was not given to the role of the citizens, businesses and industries. There is very little role played by informal private sector for emptying sludge from septic tanks. Grossly, the private sector has not been utilised in providing services for Sanitary Sewerage or wastewater management.

Chapter V

Prospects and Constrains of Public Private Partnership

5.1 Stakeholders of Public Private Partnership

The Partnership issues are discussed in depth in the paper on Urban Waste Management. The generics of PPP evolved from the possible linkages among the stakeholders involved in the Sanitary Sewerage System. In general, there are three major groups of stakeholders and three categories of partnerships linkages. The PPP is particularly known as partnership between the Government and the Private Sector. This category of partnership is the part of concern and will be discussed more in depth. The linkages and relationship of the partnership modalities will depend on the characteristics of the cooperating entities as G2B, G2C, B2C and illustrated in following chart.

Figure 3: Public Private Partnership Structure

5.2 Partnership Development Approach

The Figure 4 indicates the approaches of Partnership Development. They are:

- **Top Down Approach** – where the Government takes initiatives and call for Partnership. Such initiatives are almost rare unless it is mediated and pressurised by the Civil Societies.
- **Bottom Up Approach –** This requires influnce on Policy, Plans and Programs of the Government and very difficult to achieve.
- **Network Approach –** This approach is not dependent on Government Policy. Mostly, it is carried out by the Communities and Private Sector at grass root level following their Corporate and Social Reponsibility. The Network Partnership has very strong effect on Government Policy depending upon the strength and extend of spatial coverage of membership of the partnership. The recent political changes in Nepal could be attributed to this form of partnership where the communities and individual informal partners united for achieving a particular goal.

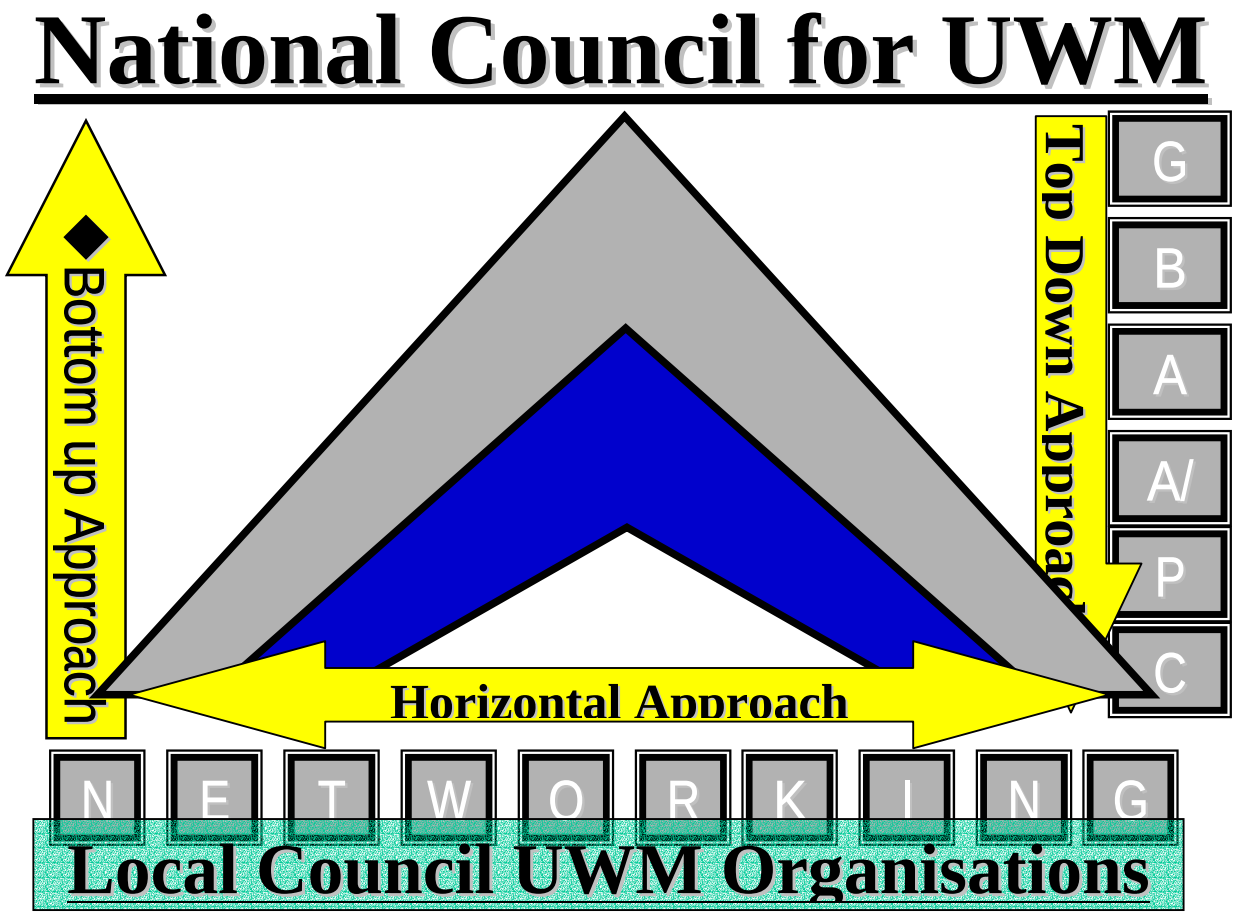

Figure 4: PPP Development Approach

5.3 Goal and Objectives of Partnership

Strengthening of the inter-sectoral partnerships in support of a long-term vision of the goals of waste management would be the key subject for WWM. The goal is to achieve sustainable WWM systems which are stable over time, and which are beneficial to the society, the economy and the environment, and to enhance the access of the citizens in an affordable manner.

The major objectives of the inter-sectoral partnership in WWM would be to:

- Identify and recognize the stakeholders and partners currently involved in WWM,
- Explore the potential new partners and define forms of partnership models to create synergy,
- Explore capability and strength of the stakeholders involved in WWM and to utilize their strength in an optimum manner,
- Define and consolidate the roles of each stakeholder partners in WWM,
- Explore the ways of economic and commercial sustainability of methodologies of waste management that protects human health and nature,
- Explore the methods of waste management that prevent waste disposal in public place and nature
- Reduce the cost of WWM to the consumers, and
- Motivate and award best practitioners.

5.4 Purpose of Partnership

The prime purpose of the Partnership would be to identify the pragmatic ways of WWM and to implement the proposed activities that will lead to the achievement of the Objectives and finally the Goals. It would explore the aspects of participation and integration of the different sectors in detail, in order to arrive at a framework for action. One of the difficulties of the task like this is the need to find access to the number of actors working in the field and with the huge differences of their objectives, purposes and approaches. [1]

5.5 Scope of Partnership

The broad scope of Partnership would be related to following activities and Tasks:

- **Investigation, research, documentation**, **and analysis** of the existing Sanitary Sewerage system, with emphasis on economy, institutional set-up, organizational capacity, roles and impact of all actors, regulatory framework, industrial and commercial infrastructure, municipal and national policy goals.
- **Capacity building, enabling, and empowerment** of all current and potential partners in order to enhance their capacity to take on new partnership roles for sustainable WWM, and particularly, to define the role of local government, formal and informal private sector, community based organisations and non-government organisations, and communities.
- The **creation of infrastructure**, preconditions, instruments, and **an institutional context** in which all partners can perform their partnership functions in relation to the development of **new models** for sustainable WWM in an optimal manner.
- **Definition of Motivation, Incentives and Awards** for recognition of Best Practices and Innovativeness in WWM.

5.6 Procurement Framework for Partnership

The Procurement framework in Nepal is based on the donors' policies and is governed by the Financial Administration Regulation of HMG including PWD and is subject to frequent changes. No policy of Procurement of Services based on PPP exists at present. A Procurement Act is currently in making and will govern the construction works, equipment and services, but the Act does not include provisions for procurement of services (solicitated or unsolicitated) based on partnership offered by private sector, non-profit and community organizations. The procurement framework shall be designed to encourage and recognize innovative and creative works and enhancing transparency through making public the selection and evaluation reports. The partnership options practiced worldwide is discussed in Urban Waste Management Paper (Refer. 27).

5.7 Key Constrains

The key constrains in terms of the development of integrated, sustainable and partnership based WWM systems are the well-identified in terms of barriers to development of inter-sectoral relationships. The constrains are discussed in various sections as Policy, Legislation and Regulations, Institutional Development, mutual Recognition, Involvement of Private Sector, Procurement and Franchise, Market and Technology, Finance, External Influence and Performance. The major constrins as barriers on legislation, procurement, technology, recognition of informal sector, resistance between public and private sector, access to financial resources, marketing, donor cooperation, and gender influence are discussed in Urban Waste Managmeent Paper (Refer. 27).

[1] UN Public Private Partnership for Urban Environment (PPPUE)

Chapter VI

Proposed Institutional Arrangement and Legislation

6.1 No defined Institutional Structure

Currently, there is no defined institutional structure at the national level responsible for overall management of Sanitary Sewerage System and WWM. The responsibility for various components of WWM is scattered among various agencies. The Ministry of Local Development is responsible for sanitation in VDC whereas DWSS for Rural Areas and most of the urban areas not covered by NWSC. The domestic or household sanitation and wastewater managmenet is not covered by any institution as Housing, and Municipalities. The industrial wastewater management is covered by the Industrial Policy Act, 1992. The Ministry of Environment deals with the environmental issues related to the Environmental Impact of the projects.

In these organizations, various other priority issues overshadow the wastewater management and for this reason WWM is not dealt in a comprehensive manner.

6.2 Review of Existing National Level Organizational Models

There are few existing institutional models that are created for dealing particular subject matter. The composition of theses Councils and the mandates are illustrated in the Table 6-1:

Table 15: Organizational Composition and Mandate

Composition	**Tourism Council**	**Environmental P Council**	**HPC for BASI**	**Solid Waste Council**	**HLC for IT**	**KMT for Nature Conservation**
Patron						King
Chairman	PM	PM	Nominated	M	Nominated	Crown Prince
Vice Chairman	M/SM			SM		
Political Representatives		2	2			
Nominated Ministers	7	8				
Nominated Secretaries	9			6		2
Authorities Representatives	3	2	7	1		1
Municipality Representatives				4		
Academia/Institute/University		3			3	1
Professionals/Experts	2		4	3		
Government Organizations			1		2	
Private Sector Associations	8	1		2	5	2
NGO		1			3	
CBO						
International Personalities						3
Total	31	18	15	18	14	11
Member Secretary	MCTCA	MOPE	Project	MLD	PS	Nominated
Responsibility	Economic	Policy	Cleaning	Minimizat	Putting	Promote,

Composition	Tourism Council	Environmental P Council	HPC for BASI	Solid Waste Council	HLC for IT	KMT for Nature Conservation
	Development and Coordination	Guidance, Coordination	Bagmati River Corridor	ion of Health and Environmental Hazard, Privatization	Nepal in Global Map by 2007	Conserve and Manage Nature
Private Sector Participation Ratio	0.26	0.11	0	0.11	0.57	0.18
Advantage	HA	HA	HA and Exclusive	HA	HA and Exclusive	VHA
Disadvantage	Low Accessibility	Low Accessibility		Low Accessibility		
Secretariat	Secretary/ Tourism Board	Secretary/ MOE	Manager	Joint Secretary, MLD	Private Sector	Nominated

Key: PM-Prime Minister, M-Minister, SM-State Minister, S-Secretary, HA-High level Authority, VHA-Very High Level Authority

From the above Table, it is evident that the formation procedure of high-level organizations is taking shift towards providing encouragement to the private sector participation in policy and decision making process and the dependency on higher authorities are reducing. It is also evident that the recent forms of institutions are more inclined to be non-executive and playing the role of a catalyst supporting the executing agencies. The case of the Steering Committee of Arniko Highway Project that enjoyed the decision-making authority equal to the Cabinet of Ministers and the Planning Commission of Kathmandu Municipality that was practiced in 2000-2004.

Several of the existing councils are headed and patronized by the higher authorities. The accessibility to these authorities is very difficult because they are chair in many institutions and the have little time for these councils. Their priority and responsibility are spread beyond the limits of UWM. For them, giving more time on UWM or Environment is not affordable. It is suggested that the higher authorities shall not be involved in these councils since they are final authorities and it is not possible for any body to raise question on them. Their involvement in these councils is simply not feasible. Particularly, the model may not be useful for when disputes arise and there is no higher authorities are available for reference and guidance.

6.3 Central Policy Making and Decentralized Execution

The review of the existing institution has reviled that there is a felt need for developing an exclusive and dedicated organization at the National level for undertaking policy issues and developing consensus among the stakeholders. Similarly, the execution, operation and maintenance issues shall be dealt at the local level following the Local Self Governance Act. The institutional responsibility shall be devolved to the local governments. The institutional arrangement described below follows this approach.

6.4 Proposed Organization, and Roles and Responsibilities

The proposed organization structure is illustrated in Figure 3. The organization comprises of a National Council as an apex body supported by theme committees, and a secretariat. The Council will be **a platform for PPP development**, a working committee comprising of **institutional representatives of Stakeholders** from Private Sector, Government Sector, Association of Municipalities, DDC, and VDC, and Academia. The Council will be a broader platform for taking initiatives for developing understanding and opening dialogue between the stakeholders, sharing knowledge and experience, preparing common plans and programs based on consensus. The adequate authority will be given to the Council for proactive functioning. Prominent leaders, renowned professionals and experts may be invited as distinguished guests.

Local councils are established at the grass root level for supporting the implementation agencies as municipalities. The local council comprises of institutional representatives of Stakeholders from the Government, Private Sector and Civil Societies.

The main function of the National Council would be:

i) Coordination with Central Government and Stakeholders,
ii) Coordination for developing better understanding and Consensus Building
iii) Coordination for sharing knowledge and experience
iv) Guiding the Policy Change, Updating Legislation and Regulations,
v) Preparation of common Plans and Programs
vi) Support creating and operating the proposed UWM Fund (that include revenue from Sanitary Sewerage
vii) Guiding the preparation of Implementation Strategy and Manual of Procedures,
vi) Supporting for Capacity Building and Technology Transfer
vii) Guiding the Partnership and Enterprise development through Franchising,
viii) Support for Studies, Research, Market and Development**,**
ix) Creation of Data, Information Bank and Knowledge Centre,
x) Facilitation for Clearance of Documents, Procedures, Plans and Programs,
xi) Facilitation for Motivation to Stakeholders,
xii) Catalytic Support to Executive Agencies,
xiii) Surveillance, Monitoring and Evaluation

The National Council and Local Councils do not interfere into the functioning of the existing executing agencies. If required, they could be instrumental for institutional reforms. More details are described in UWM Paper (Refer 27).

Chapter VII

Proposed Enhancement of Services of Sanitary Sewerage

7.1 Principles of Choice of Sanitary Sewerage Systems

Based on the lessons learnt, the approach for selection of Sanitary Sewerage system may be based on following principles:

1st Principle: Waste Management at Source
2nd Principle: Choice of Technology (based on Environmental Standards and Economy)
3rd Principle: Building Consensus and approval by Stakeholders
4th Principle: Follow up, Monitoring & Evaluation

Fundamentally for Semi-urban and Rural areas, the On-Site Sanitation comprising of Pits, Septic Tank, Eco-san Toilets, Cesspool (with Aeration system in future) would be basic sanitation system whereas the institutions/organisations as hospitals, housing complexes, educational campuses and universities, industrial houses and other organised sector shall develop Independent Sanitary Sewerage System that would be treated within their premises and effluent discharged to Nature or City Network would be prohibited.

The existing sewerage systems in Kathmandu Valley towns and other cities as Panauti, Dhulikhel, Hetauda, Bidur, Kamalamai and Dhadingbesi require rehabilitation, recover the assets and bring into the functioning, and gradually transfer into separate system in order to enhance the sustainability of the sanitary sewerage system including that of the treatment plants. Tables 7A and Table 7B indicate the comparative advantage of the separate sewer system and need for introduction of Waste Management at Source System (with use of aeration systems) and improving affluent quality prior to disposal to the city sewerage system.

The densely populated urban areas may prefer Separate System and if necessary may combine with Septic Tank with Small bore plastic sewers. At places the On-Site Sanitation would be applied. The Combined Sewer system with mixed sanitation and surface drainage would be the least preferred system that would be gradually improved to separate system.

The Aeration Lagoon will be the basic sewage treatment method. Based on the actual need and severity of the local conditions Advanced Treatment System will be applied. The selection of the system will be guided by the ability to handle sludge volume. Lagoons will be preferred where Sludge may be used for conditioning of agricultural soil, and composting besides land availability, energy prices, skill and management capacity, affordability. The Reed Bed Plants as practised worldwide is suggested for application for tertiary treatment unless it is proved through intensive research for other uses.

7.2 Criteria for Choice of Services and SS System

The category of Sanitary Sewerage services could be based on category of settlement areas, particularly urban and semi-urban areas. The choice of the services would broadly based on the following parameters:

- **Location –** Suitability of Soil for on-site sanitation and level of ground water and flooding conditions
- **Environmental Standards** – Levels of contaminants as TSS, BOD, Pathogens and chemicals allowed to be disposed off in the natural water bodies

- **Scale of economy** – Affordability and willingness of the consumers to pay for the capital investment, and O&M
- **Efforts to Reduce Price for the Consumers** – An effort to search for cost effective solutions for given context
- **Sewerage Connection Permission** – Include process for obtaining Sewerage Connection Permission as a part of Building Permit Process in Urban and rural areas for all consumers and stakeholders.
- **Environmental Auditing** – Every system developed shall be subject to periodic environmental and performance auditing, follow up, monitoring and evaluation.

7.3 Approach for Service Enhancement and Development of SS

The Service Enhancement and Development of Sanitary Sewerage approach has three parts:

a.) Bringing the existing system to function i.e. eliminating the weaknesses and short comings of the existing system and to carry out rehabilitation works based on Choice of category of sanitary sewerage system,
b.) Separation and diversion of Storm Water and Sewage flow to allow proper treatment of sewage, and
c.) Search for cost effective and environment friendly solution for new development.

The stepwise activities are summarised in proposed action plan in Table 11-1 and summarised herewith.

Apart from the Institutional reforms and partnership building among the government, stakeholders and the community, following steps would be paramount:

A. For Existing System

Step-1: Preparation of the inventory of sewer systems (Storm water and sanitary sewers) and treatment plants
Step-2: Consensus Building on the appropriateness of Type of Sanitary Sewerage System (Separate or combined or both for a particular area or location).
Step-3: Rehabilitate the existing sewer system to follow the adopted system of separate or combined system, and controlling infiltration and avoiding storm water flow in the sanitary sewerage system
Step-4: Rehabilitation or upgrading of existing WWTP to accommodate the wastewater loads based on the separate sanitary sewerage system
Step-5: Define operation and maintenance system and encourage Private sector enterprise for out sourcing of services where the existing capability of municipalities and NWSC is not adequate
Step-6: Encourage Private sector for capital investment in the operation and maintenance of existing system
Step-7: Utilise Sewerage Revenue for O&M and R&D of Sanitary Sewerage Sector.
Step-8: Develop Rules, Regulation and Manuals for operation and maintenance, surveillance system.

B. For New System

Step-9: Establish Final Authority (or utilize NCUWM, if approved) for consensus building and clearance of plans and programs and projects for a particular location
Step-10: Review Policy in relation to particular location and project based on centralised policy making and decentralised execution, operation and maintenance
Step-11: Develop SS Systems based on general criteria defined above.
Step-12: Follow steps Step-2 to Step-8.

Chapter VIII

Resource Management

8.1 Human Resources

As SS system or WWM is a local issue and shall be implemented following the Decentralization Policy and mobilisation of PPP. This appoach will demand major changes in approach and developing the understanding both at public and private (Formal and Informal) sectors levels. There is a need for capacity building of both public and private sector for handling the policy changes and executing the new roles and responsibilities. The human resources available at various levels need to be redirected for use at National and Local governments.

Capacity Building of the Public and Private sector would be another important task in order to develop the required level of skill for management, construction, operation and maintenance, and environment friendly waste disposal and treatment. Appropriate training for various skills and safety measures shall be considered.

8.2 Capital Resources

The capital resource required for development, operation and maintenance of SS will be possible to raise from the formal and informal private sector provided attractive and pragmatic motivational and incentive schemes are developed. The problem raised due to starvation of capital resources for the formal and informal sector will be solved in many ways. The capital inflow and support of the banking sector may be possible if economically viable combination of resource mobilization approach could be derived and PPP is established.

8.3 Creating WW Management Fund

The fund for WWM is envisaged to evolve from the WW tax and grants from the central and local governments. The proposed UWM Fund may utilised for management of the WWM Fund that comprise of contribution of various financial sources such as:

Saving of costs induced by the proposed Reforms

- Saving of Expenditures of Municipalities and Government

Taxes and Revenue

- Sewerage Revenue from resident citizens,
- Wastewater disposal fee into sewerage system or nature
- Revenue from Polluters (Polluters Pay)

Contribution from various funds

- Environment Protection Fund,
- Tourism Development Fund,
- Government and International Commitments
- Municipality

Revenue from Outsourcing of Services

- Business Licensing for Outsourcing

8.4 Available Resources

Brief information on the currently available resources is provided below.

Taxes collected by NWSC

The taxes collected by NWSC for WWM and included in the watersupply revenue comprise of 25% of water tariff should be used for contributing to UWM Fund.

Saving of Expenditures induced from the proposed Reforms

The PPP for WWM, if applied in a proper way, would bring a lot of reforms and save lot of resources currently used by NWSC and municipalities for operation and maintenance, and repair. The cost of damage done to the nature, environment and human life may be evaluated and recovered from municipalities and the government (?). The resources saved from the proposed WWM approach should be utilized for the sector and contribute to UWM Fund.

Revenue from residents and Polluters

A fee system for all residents of urban and peri-urban areas shall be applied in a mandatary manner along with the charge of penalty for pollution created. The fee structure shall be graded at several layers based on the method of WWM used by the consumers and quality of wastewater discharged.

Revenue from Beneficiaries

The improved urban and rural environment brings positive benefits to a number of business and industries and Municipalities, Government (enhanced image and saving on environmental recovery), tourism industry (increased business) and communities (improved health and enhanced quality of life). The situation enhances the business as a whole. Certain part of their incremental benefits shall be shared for Wastewater Management.

Government Grants and Incentives

The Grants and Incentives from the Government and Donor Agencies provided to the Municipalities, DDC and VDC should be made available for strengthening the UWM Fund and providing incentives under PPP Programs.

Chapter IX

Motivation, Incentives and Awards

9.1 International Experience

Several countries have adopted various methods to motivate and encourage the communities, formal and informal sectors for taking initiatives in Urban Waste Management. This kind of incentives certainly reduce the burden on the government and municipalities and help to achieve the objectives and help to implement UWM System in a successful manner.

9.2 Motivation to the enthusiasts

The creation of motivation to the enthusiasts, employees and Waste Management Partners would be the key approach for developing sustainable partnership among the stakeholders in Urban Waste Management. Some of the cases of motivation factors are presented herewith:

- The waste generation at the households, business and industry level is directly based on the fact that municipalities accept the Throw Away Waste at free of cost. The citizens and the business are encouraged to generate more waste and add more burdens to the municipalities. In the contrast, a motivation factor for practicing of Waste Management at Source requires applying a fee based on "Pay As You Throw Away (PAYTA)". In the local context, the municipality waste collection tippers shall charge a fee for every bagful of waste thrown away.
- Funding for developing sustainable partnership among the stakeholders for WMS, cleaner effluent, and reducing disposal to sewerage system or nature, encouraging reuse and recycling. These funding may be applied with establishment of WWM Fund.
- Tax Waiver or return incentives to the business and industries may be a good motivation factor for enhancing waste reduction at source and for cleaner effluent disposal.
- The incentives provided to the communities and users for alternative energy schemes shall be continued.

9.3 Some categories of awards

Awards are one of the ways to encourage the stakeholders to participate and develop partnership for WWM and provide opportunity for setting good examples. Awards could be in the forms of recognition and use of economic instruments through establishments of Excellence Awards for considerable achievements.

Chapter X

Conclusion

10.1 Policy Review and National Image

The status of WWM is the reflection of National Image and Economy caused by the execution of the policy and commitments to follow the provisions in the Constitution, Acts, Regulations, Plans and Programs and International Agreements. The review firmly established the commitment of GON towards Environmental Protection and hazard free wastewater management.

10.2 Scattered Responsibilities

The commitments for Environmental Protection and WM are scattered in many policies, acts, regulations and dealt by several ministries, departments, and local governments. At the same time, none of them are comprehensively responsible. For example, wastewater is dealt by MPPW for urban and peri-urban areas whereas MLD is responsible for rural areas, but at the same time rural sanitation is attached to the rural water supply, and MOICS deals with industrial wastewater, and the MOEST deals with environmental issues. The waste management issues are overlapped with municipalities and DDC. It seems it is the business of every body but nobody's responsibility.

10.3 Loss of Economy and Tourism Business

Indiscriminate disposal of wastewater in the rivers and ponds has detrimental effect on the environment, human health and economy. The business loss in tourism industry in Nepal is very much attributed to the worsening WM. The river corridors in Kathmandu Valley has a deficiency in natural Oxygen supply because of the high BOD demand of the waste water flowing in the river systems. Many of the urban housing along the river corridors are abondoned due tot he worsening environmetla degradation. Wastewater amounting 370 (?) MLD is discharged into river system or ground water.

10.4 Lessons from Past Failures

The majority of the wastewater treatment plants remained defunct because of lack of appropriate operational capability, poor quality of sewerage system and mixing of surface waster drainage containing sand and silt and sewage flow. As a consequence, wastewater is discharged to the river without treament. The rehabilitation of these WWTP (specially Dhobighat, Sallaghari and Hanumanghat) is overdue since 1995 and is pending because of the institutional barrier created the government level and bundling with Melamchi Water Supply Project. This is another hurdle that created pollution of the river system in Kathmandu valley and extinction of the aquatic life.

The poor construction quality of the sanitary sewerage system has contributed to the pollution of water supply pipelines and the surrounding soil mass and ground water.

The mixing of storm water drainage has brought a lot of silt, sand and solid waste into the sanitary sewerage system causing blockage of the sewers, and disruption of pumping stations.

This process is aggravated by the activities of municiplaities which under the community support program extending the combined sewerage any kind of sewerage system without any regards.

The constructed wetland system applied in Dhulikhel, Pokhara and Thimi are not complete in design and used for secodary treatment rather than for designated purpose of tertiary treatment has created operational and environmental problems.

The current approach of "Do Nothing, unless Donors Assist" shall be changed and take immediate measures to rehabilitate the defunct WWTP, and sewerage system. Otherwise the Greater Kathmandu may prepare to face a big catastroph of large scale epidemics.

10.5 Lessons Learned from Good Practices

The domestic sanitation coverage reached 46% in Year 2004 (HRD 2005) and mostly consisted of on-site sanitation using septic tanks including major parts of the urban and peri-urban areas. Certain communities and individuals started utilising wastewater for recovery of greenhouse gases combined with Biogas plants.

The wastewater effluent standards for domestic and industrial WW are developed.

The participation of stakeholders, communities and private sector in wastewater sector is practically very large contributing to the sanitation coverage indicated above, but private sector enterprise development for providing waste management services has not been observed except for services for emptying septic tanks.

Chapter XI

Recommendation

11.1 Proposed WWM Approach

Grossly, the WWM in Nepal remained at low priority level for many organizations since they have many other subjects to deal with. But, naturally the sources of generation of wastewater are the same as for solid waste and gas. The logical steps towards resolution of the institutional issues related to WWM would be to consider all three components (Solid, liquid and gas) in a comprehensive way as an important urban infrastructure at par with other infrastructure as Water Supply, Roads, Telephone, and Electricity, and avoid duplication of efforts. The proposed NCUWM would be a perfect choice for WWM to join with.

11.2 Need for PPP

The lessons learned had very clearly indicated that waste is generated by all stakeholders and is managed by the Government agencies or municipalities and remained beyond their capacity. This situation demands for new, innovate and flexible approach and mobilizing the various stakeholders as partners for efficient delivery of services, development of cost effective and sustainable systems, monitoring of progress, surveillance and checking of appropriateness of decisions made. In this context, the Public Private Partnership could best address the requisite for involving the community in WWM.

11.3 Modalities of PPP

There are several modalities of PPP practiced worldwide. The choice of particular modality will depend on the scope of works; local situation and delivery of services required and shall be left to the potential partners. However, the PPP modalities require that the civil society is always included as the third party in order to maintain check and balance and to make independent judgement by the consumers of the conditions of contract agreement, and be the owner of the decisions made.

11.4 Need for Exclusive, Dedicated and Autonomous Organization

The WWM is currently dealt by several organizations in a piece mill basis. The implementation of plans and programs is very weak and inconsistent. This situation invites to work out for development of a comprehensive and integrated policy dealt by an exclusive and dedicated organization.

Thus, establishment of an exclusive organization dedicated in the WWM is recommended together with establishment of corresponding local councils. The proposed exclusive organization may join the National Council for UWM, if approved by the Government. The council will truly be a representation of PPP at the apex level and will comprise of representatives of institutional stakeholders including the Government Ministries, Municipalities, Associations and Societies of formal and informal private sector organizations, and civil societies. The council will be a platform for brainstorming, developing consensus, developing common plans and programs and clearance of procedures

and projects, and monitoring progress. The Council will be a catalytic support organization to the existing executing agencies and will be a custodian of the proposed WWM Fund.

A parliamentary committee, environmental audit committee, dispute resolution board and specialized judiciary and civil societies that will advocate for qualitative and timely performance will support the exclusive organization.

The major role and responsibility of the Exclusive Organisation will be for development of PPP for providing cost effective services in WWM, coordination among the stakeholder organizations, providing Policy Guidance and Regulation, updating Implementation Strategy, facilitating preparation of Plans and Programs, capacity building of stakeholders, technology transfer, providing support for studies, research, market and encouraging enterprise development, creation of data and information bank and knowledge centre, facilitation for clearance of documents, procedures and projects, motivation to stakeholders, providing catalytic support to executive agencies, and facilitating the consensus building.

Currently, there is no designated responsible organization to look after the surface water drainage and river system and nobody resumes responsibility for mismanagement of wastewater sector. No case of PPP in wasterwater sector is identified sofar.

The activities of the proposed Exclusive Organisation shall be focused on Action Plan proposed in the following chapter based on consensus between the stakeholders and priorities established.

Chapter XII

Proposed Action Plan

12.1 Proposed Major Activities

The proposed action plan (Table 1) comprises of the major activities related to the steps of implementation of the proposed WWM program. The proposed actions are divided into immediate/ short- term and long-term actions. The general characteristics are described herewith and provided in details in Appendix-5:

12.2 Immediate Actions

The immediate actions categorically include:

1) Nomination of Ad Hoc Exclusive Organisation (or joining NCUWM, if approved by the Government)
2) Prepare business plan, personnel policies and secretariat staffing
3) Defining institutional structure of proposed Exclusive Organisation at National and Local Levels,
4) Formulating roles and responsibilities, by-laws, task assignments, job description,
5) Preparation of Manual of Procedures (Procurement, Franchising, Partnership Models, Operation and Maintenance),
6) Developing economic instruments for motivation, incentives and awards, and development of initial programmes
7) Identification of modalities of implementation of recommended immediate actions,
8) Identification of resources, and legal instruments,
9) Awareness and consensus building among the stakeholders through organisation of national seminars,
10) Develop inventory of the system, data and information
11) Preparation of TOR and identification of resources for detailed studies and implementation of Action Plan.
12) Development of Feedback, Review and Reform Procedures.
13) Develop Programs for providing sanitary sewerage services as inspection and cleaning of sewers, prevention of solid waste dump, repair and maintenance, segregation of storm water and sanitary sewerage system (See Appendix-4) through capacity building of municipalities, civil societies, communities and outsourcing to private sector.
14) Develop Programs for rehabilitation of existing assets including separation of sanitary and storm water sewerage system and WWTP;
15) Develop programs for R&D and further studies in Sanitary Sewerage Sector

12.3 Long Term Actions

The long-term actions for WWM include the following:

1) Policy Reforms

a. Legislative and Regulatory Framework Reforms: Developing legislative and regulatory framework for WWM based on PPP. The procedures for review of WWM policy, environmental guidelines, community rules and regulations; tax and incentive

structure shall be included in the framework. The policy of Central Policy making and Decentralised Execution may be the fundamental principle of WWM.

b. **Amendment of relevant Acts: W**WM issues shall be incorporated within the score of acts and regulations in order to make it inherent part of the corresponding sectors as Housing, Building and Urban Development, Water Supply and Sanitation, Industries and Business houses, institutions and individual households. WWM shall be the part of social and corporate responsibility of all stakeholders and shall be incorporated by Law. A Manual of Procedures for implementing the proposed policy action, and enhancing the consistency in policy implementation across the executing agencies shall be prepared. Environmental Audit shall be an inherent activity all stakeholders in the line with financial and tax audit.

2) Institutional Arrangement

a. **Consensus Building on proposed institutional model:** The consensus building procedure will include several seminars and workshops with stakeholder organisations and individuals. Wide discussion with policy makers and legislature shall be carried out based on Long-term WWM concept and approach. Participation of the policy makers in important meetings, seminars and conferences shall be encouraged. The process would finally involve the government decision to establish such an institution.

b. **Establishment of supportive committees:** The establishment of supportive committees such as: a) Parliamentary Committee on WWM, b) Environmental Audit Committee and c) Empowering Civil Societies would be important steps.

3) Strategy Formulation

a. **Building Implementation Capacity:** The implementation capacity of authorities at various levels shall be developed through appropriate training and sharing of knowledge. Implementation capacity is largely dependent on the policy of selection of right person in right place. This will require a radical change in the current policy of recruitment of authorities and shall be based on merit, competitive approach and performance oriented. The capacity building activity shall be extended for support of the formal and informal private sector to serve as partners for local governments,

b. **Developing Social And Corporate Responsibility:** Define WWM as social and corporate responsibility of households, business houses, industries and institutions, and include in the respective acts and regulations including responsibility for Corporate Environmental Assessment

c. **Developing Marketing Strategy for Services:** The marketing strategy for WWM services will be developed with application of the economic instruments to encourage the communities, formal and informal sectors to provide efficient services.

d. **Support to Innovation, Creativity, Research and Development:** Develop Procurement and Franchising framework for supporting innovative and creative offers, research and development and studies shall be developed based on the standard procedures including unsolicited offers as a part of Public Private Partnership.

e. **Development of Public Private Partnership Programme:** The programme would focus on the modalities of public private partnership encompassing most of activities related to the WWM from policy development, strategy formulation, centre information dissemination, knowledge management, community development, awareness building and motivation, waste management service delivery, capital investment, surveillance, environmental auditing, monitoring and evaluation, motivation, incentive, and rewards.

f. **Strengthening the working relationship with the communities:** The working relationship with the communities shall be improved with increased interactions and exploring the root cause of waste disposal and opportunity for bringing change in behaviour of communities towards waste disposal and particularly for segregation of storm water and sanitary sewerage system and prevention of solid waste dumps in Wastewater system.

g. **Generating More Water for cleaning river systems:** Following the principle of "Dilution is the Solution of Pollution", it is very essential that more water is needed for flushing the river systems in Kathmandu Valley. This action particularly demand for: i) Implementation of water conservation program, ii) treatment of grey water and recycling iii) prevention of urban development in Ground Water Recharge Zones, iv) Limiting population growth and urban development based on water supply capacity, and v) Allowing at least 25% of natural river flow at all times.

4) Implementation Approach

a. **Service Delivery:** The delivery of enhanced services (See Appendix-4) in Sanitary Sewerage would include continuity of the services provided under Immediate Action Plan and rehabilitation, and extension of services in peripheral areas not covered by the services before. It would also include water quality monitoring and environmental improvement activities.

b. **Intervention in the Existing System:** The major works related to the existing system are rehabilitation of the sewerage system and treatment plants with aims to bring back to functional level and eliminating environmental and health hazard. The proposed intervention may include activities to improve wastewater quality at household level with:
   - Introduction of plastic septic tanks to trap undissolved solid and aeration before disposal to Sanitary Sewer or to soak pits.
   - Encouraging use of Ecosan toilets as a choice in rural areas or wastewater use for Biogas generation
   - Introducing Biofilter WWTP or Aerated Lagoons at sewerage outfalls to rivers or introduction of aeration facilities at certain points of river stretches (?).
   - Carry out study to utilising Existing Pumping Station at Sundarighat as Biofilter WWTP and utilise Dhobighat Treatment Plant for Patan South Sewerage zone.

c. **Innovative Approach for New System:** Development of new sanitary sewerage system requires very rational and pragmatic approach. Considering the fact that separate sanitary system requires storm water drainage to be developed simultaneously, the task of managing waste water system becomes unpractical. This fact calls for consideration of a new approach with introduction of Aerated Watertight Septic Tanks at all households and discharging the affluent to the surface water drainage system. The affluent quality needs to be monitored strictly. This may avoid need for sanitary sewerage system and central WWTP. The final decision shall be based on case-to-case situation and will be based on local condition, environmental, economic consideration approval of the final authority.

12.4 Proposed Activities for WWM

Some limited activities (Do-ables!) are proposed herewith in Table 1 that may be possible to carry out and achieve some success.

12.5 UWM Fund

It is proposed to create a special fund for UWM by transfer of resources saved due to the application of UWM Policy and additional resources generated from various activities related to UWM as Taxes, Contribution from various funds, and Revenue from Waste Generators. The funds shall be utilized to facilitate, motivate and outsourcing of services, research and development and supporting the municipal activities. The National Council would be the custodian of the Fund.

12.6 Implementation Strategy

A number of steps shall be included as fundamental principles of implementation strategy. These steps are:

- Including all Associations of Organizations relevant to UWM as members of NC (with unlimited membership number)
- Facilitating Reform of Acts and Regulations
- Introducing Incentive Credit Schemes for individuals and organizations for Initiatives and active participation (Detailed Study required)
- Conduct meetings every two weeks (No Quorum required)
- Develop Economic Tools for Motivation, Incentives and Awards
- Attach Partnership models with economic tools as separate fees for capital investment and operation fees based on actual performance or service delivery
- Empower Civil Societies and Stakeholders for monitoring and surveillance
- Strengthen Existing Executing Agencies
- Strengthening Waste Market
- Conduct Workshops, Seminars, Conferences jointly with stakeholder Organizations.

12.7 Policy Action Matrix

The proposed Policy Action Matrix for implementing the recommendation for development of the PPP for UWM is provided in Appendix- 5. The Policy Action Matrix has been developed based on constrains and issues of Public Private Partnership in relation to UWM with the objective to protect the environment and human Health. The matrix indicates the list of major activities, measurable indicators, the potential responsible organization and time period for implementation.

Chapter XIII

Rationale of Partnership

13.1 Some points of Rationality

Some of the points that highlight the rationale of the proposed measures and recommendation could be as follows:

- Establishment of exclusive and dedicated organization
- Participation of various partners has visible advantages as greater efficiency, enhanced performance, greater flexibility, access to capital resources, reduction of operational risks, reduction of waste materials and emission, reduction of cost to consumers, extension of life time of capital investments as landfill sites, employment generation, and several other benefits.
- A permanent platform is created for continuation of dialogue, interaction and sharing of experience.
- An independent mechanism of funding is created
- Motivation, incentives and awards act as driving force
- Sustainability is enhanced with reduction of cost to the consumers
- New business and employment opportunities are opened in a transparent and competitive environment.

Chapter XIV

Sustainability

14.1 Enhancing Trust, Believe and Confidence

The question of sustainability of the various methods of Waste Management described above is reviewed herewith. There are several constrains facing UWM and compounded by the limited vision, limited purpose and resources available to the partners in SWM. There is no simple measures to loosen or remove these constrains. One of the reasons for the difficulty of felt resistance to changes is the characteristic of the partners to protect themselves from external influence and felt risk to their secured jobs and benefits they enjoy with current settings. The suggested ways may enhance the trust, believe and confidence between the stakeholders through regular interaction, dialogue and demonstration of fulfillment of commitments through performance in practice.

14.2 Methods for Enhancing Sustainability

Some of the proposed measures to produce successful UWM may comprise of a set of reforms as:

- Institutional Arrangement and Legislation
- Public Private Partnership Modality
- Enhancing Social and Corporate Responsibility
- Financial Resource Management
- Motivation, Incentives, and Rewards.

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Appendix 1: Terms of Reference

Study Topic: *Service Enhancement and Development of Sanitary Sewerage System in Urban and Semi-urban Setting in Nepal*

This assignment is equivalent to effective one person-month. The consultant should establish adequate interactions with key informants, stakeholders and government agencies while conducting study and observing real site conditions.

Task details:

1. Review the present scenario of sewerage system in selected established and emerging towns of Nepal highlighting current service difficulties and future opportunities.
2. Review the existing plan, policy and act of the government regarding sewerage system services, wastewater treatment, and disposal and trend of wastewater disposal.
3. Identify the gap between need and realities in terms of sewerage system, wastewater treatment and disposal and environmental consequences.
4. Review and analyze the role of Government, Municipalities and other stakeholders identifying coordination mechanisms.
5. Suggest necessary policy reforms indicating technical, institutional, legal, financial, environmental, and sustainability point of views.
6. Set a comprehensive strategy for institutional strengthening and reform, enhanced effectiveness in planning and implementation, and public- private initiatives for overall management and costing.
7. Suggest a policy-action matrix containing (a) constraints (policy, legal, institutional, administrative, technical and other applicable); (b) recommended policy improvement; (c) activities; (d) indicator of achievement; (e) responsible agencies; (f) time frame (immediate, intermediate and long term)
8. The paper should include an executive summary not exceeding five pages.
9. Consultant is requested to provide a short article, in English or Nepali, related to the above topic, to be published in a national daily for information dissemination.
10. Submit draft report (electronic and hard copy) to EPN Focal Unit within 30 days from the date of assignment.
11. Present the draft report at the advisory Committee meeting (to be scheduled by EPN Focal Unit.
12. Present revised draft (incorporating comments from the Advisory Committee and external reviewer) at the workshop organized by EPN Focal Unit.
13. Present final report (incorporating comments from Workshop) at the Advisory Committee meeting for final validation.
14. Submit final report to EPN Focal Unit (electronic and hard copy).

Appendix 2: Population in designated urban areas 1952/54 - 2005

Rank	Population / Municipalities	1952/54	1961	1971	1981	1991	2001	GR 81-01%	2005	GR 1-5 %	WW Demand, MLD
1	Kathmandu (Kathmandu)	106,579	106,579	150,402	235,160	421,258	671,846	5.39%	790,612	4.15%	63.25
2	Pokhara (Kaski)		5,413	20,611	46,642	95,286	156,312	6.23%	186,410	4.50%	14.91
3	Lalitpur (Lalitpur)	42,183	47,713	59,049	79,875	115,865	162,991	3.63%	183,316	2.98%	14.67
4	Biratnagar (Morang)	8,060	35,355	45,100	93,544	129,388	166,674	2.93%	182,331	2.27%	14.59
5	Birganj (Parsa)	10,037	10,769	12,999	43,642	69,005	112,484	4.85%	133,244	4.33%	10.66
6	Dharan (Sunsari)		13,998	20,503	42,146	66,457	95,332	4.17%	108,605	3.31%	8.69
7	Bharatpur (Chitwan)				27,602	54,670	89,323	6.05%	107,162	4.66%	8.57
8	Janakpur (Dhanusha)	7,037	8,928	14,294	34,840	54,710	74,192	3.85%	93,796	6.04%	7.50
9	Dhangadhi (Kailali)				27,274	44,753	67,447	4.63%	92,326	8.17%	7.39
10	Butwal (Rupandehi)			12,815	22,583	44,272	75,384	6.21%	91,737	5.03%	7.34
11	Mahendranagar(Kanchanpur)				43,834	62,050	80,839	3.11%	88,386	2.26%	7.07
12	Hetauda (Makwanpur)			16,194	34,792	53,836	68,482	3.44%	84,800	5.49%	6.78
13	Bhaktapur (Bhaktapur)	32,320	33,877	40,112	48,472	61,405	72,543	2.04%	76,890	1.47%	6.15
14	Siddharthanagar (Rupandehi)			17,272	31,119	39,473	52,569	2.66%	63,372	4.78%	5.07
15	Trijuga (Udayapur)					37,512	55,291	3.96%	63,340	3.46%	5.07
16	Nepalganj (Banke)	10,813	15,817	23,523	34,015	47,819	57,535	2.66%	61,477	1.67%	4.92
17	Madhyapur Them i(Bhaktapur	8,657	9,719			31,970	47,751	4.09%	54,905	3.55%	4.39
18	Mechinagar (Jhapa)					37,108	49,060	2.83%	54,073	2.46%	4.33
19	Gulariya (Bardia)					30,621	46,011	4.16%	53,110	3.65%	4.25
20	Tribhuvannagar (Dang)				20,608	29,050	43,126	3.76%	49,426	3.47%	3.95
21	Itahari (Sunsari)					26,824	41,210	4.39%	47,987	3.88%	3.84
22	Lekhnath (Kaski)					30,107	41,369	3.23%	46,221	2.81%	3.70
23	Tikapur (Kailali)					25,639	38,722	4.21%	44,762	3.69%	3.58
24	Kirtipur (Kathmandu)				7,038	5,764	40,835	9.19%	44,635	2.25%	3.57
25	Ratnanagar (Chitwan)					25,118	37,791	4.17%	43,665	3.68%	3.49
26	Kalaiya (Bara)					18,498	32,260	5.72%	39,367	5.10%	3.15
27	Tulsipur (Dang)					22,654	33,876	4.11%	39,061	3.62%	3.12
28	Kamalamai (Sindhuli)					24,368	32,838	3.03%	36,440	2.64%	2.92
29	Birendranagar (Surkhet)				13,859	22,973	31,381	4.17%	34,986	2.76%	2.80

30	Damak (Jhapa)					41,321	35,009	-1.64%	33,766	-0.90%	2.70	
31	Rajbiraj (Saptari)		5,232	7,832	16,444	24,227	30,353	3.11%	33,063	2.16%	2.65	
32	Kapilbastu (Kapilbastu)					17,126	27,170	4.72%	32,139	4.29%	2.57	
33	Byas (Tanahu)					20,124	28,245	3.45%	31,826	3.03%	2.55	
34	Lahan (Siraha)				13,775	19,018	27,654	3.55%	31,497	3.31%	2.52	
35	Putalibazar (Syangja)					25,870	29,667	1.38%	31,043	1.14%	2.48	
36	Prithvinarayan (Gorkha)					20,633	25,783	2.25%	27,845	1.94%	2.23	
37	Panauti (Kavre)					20,467	25,563	2.25%	27,604	1.94%	2.21	
38	Gaur (Rautahat)					20,434	25,383	2.19%	27,327	1.86%	2.19	
39	Dipayal (Doti)					12,360	22,061	5.96%	27,088	5.27%	2.17	
40	Inaruwa (Sunsari)					18,547	23,200	2.26%	25,031	1.92%	2.00	
41	Siraha (Siraha)					21,866	23,988	0.93%	24,659	0.69%	1.97	
42	Ramgram (Nawal Parasi)					18,911	22,630	1.81%	24,014	1.50%	1.92	
43	Jaleswar (Mahottari)					18,088	22,046	2.00%	23,574	1.69%	1.89	
44	Kalika (Baglung)					15,219	20,852	3.20%	23,297	2.81%	1.86	
45	Tansen (Palpa)		5,136	6,434	13,125	13,599	20,431	2.24%	23,190	3.22%	1.86	
46	Khandbari (Sankhua)					18,756	21,789	1.51%	22,904	1.26%	1.83	
47	Bhimeswar (Dolakha)					19,260	21,916	1.30%	22,851	1.05%	1.83	
48	Dhankuta (Dhankuta)				13,836	17,073	20,668	2.03%	22,085	1.67%	1.77	
49	Bidur (Nuwakot)					18,694	21,193	1.26%	22,063	1.01%	1.77	
50	Waling (Syangja)					16,712	20,414	2.02%	21,869	1.74%	1.75	
51	Narayan (Dailekh)					15,738	19,446	2.14%	20,910	1.83%	1.67	
52	Malangwa (Sarlahi)	5,551	6,721			14,142	18,484	2.71%	20,285	2.35%	1.62	
53	Bhadrapur (Jhapa)			7,499	9,761	15,210	18,145	3.15%	19,524	1.85%	1.56	
54	Amargadhi (Dadeldhura)					16,494	18,390	1.09%	19,015	0.84%	1.52	
55	Dasrathchand (Baitadi)					18,054	18,345	0.16%	18,318	-0.04%	1.47	
56	Ilam (Ilam)			7,299	9,773	13,197	16,237	2.57%	17,492	1.88%	1.40	
57	Banepa (Kavre)		5,688			12,537	15,822	2.35%	17,154	2.04%	1.37	
58	Dhulikhel (Kavre)					9,812	11,521	1.62%	10,170	-3.07%	0.81	
	TOTAL	238,275	336,222	461,938	956,721	1,695,719	3,227,879	6.27%	3,698,045	3.46%	296	

Note: data Missing
GR 81-01 % is calculated with figure for 1981 or 1991 which ever is older available
GR 1-5 % is estimated based on estimated Population for 2005

Appendix-3: Sanitary Sewerage Systems

Sanitary Sewerage Systems comprise of two main components: Conveyance system and Treatment Systems. A brief description of the systems are given herewith.

Conveyance Systems
Gravity Systems

Conventional gravity sewers convey raw, untreated sewage through sewer pipelines to a treatment facility or pumping station. The sewer lines are straight and installed on a specific horizontal and vertical alignment, with interspaced manholes placed at set intervals (< 30m), at pipe intersections and at changes in pipeline direction. The pipes are installed with uniform gradients sufficient to create a self-cleansing velocity of 0.6 m/sec.

Concrete manholes allow access for inspection, cleaning, and repair.

These systems on flat terrain typically require deep excavations (2 to 8 m below grade) and proper preparation and bedding materials are required in the pipeline trenches. The sewer line to Sundarighat pumping station is laid at a depth of 10-15 m.

Normally, the depth of burial of sewer lines is restricted to 6 m, at which point a lift station is built to pump wastewater to another location, such as another pump station or a wastewater treatment plant through a force main.

The sewers and manholes are most typically installed along the center line of roadways and have service collection laterals extending perpendicular to the roadway alignment.

If required, a lift/pump station collects the sewage transported by the collection piping.

The station consists of a wet well with either submersible or non-submersible pumps. These pumps are sensitive to the silt and sand contained in the sewage flow.

Typically, two alternating, non-clog wastewater pumps remove waste from the collection tank and discharge it through a force main.

Small Bore Sewers

The small-bore sewerage system is a high breed of On-sit Sanitation and standard sanitary sewerage system. The Interceptor tanks (Septic tank) are introduced in the collector sewers for trapping the non-biodegradable solids. Only the liquid part of the sullage is transported to the sewerage system. The small-bore system requires smaller pipe compared to the standard sewerage system. The disadvantage of this system is that the residents around this require to invest on the retention tank, which is unlikely and due course of time the people will connect to the collector system directly without the retention tank irrespective of the size of the sewer; there is a need for treating the effluent from the retention tank since BOD has not reduced, retention sludge has to be removed from time to time and small bore sewer cannot be smaller than 200mm for operation and maintenance purpose.

Combined VS Separate Sewers

Sanitary and Storm water sewers have very different objectives and specifications. Combined sewers require storm relief structures so that the treatment plant is not overloaded with storm water and silt. The combined sewers are designed for higher velocity of flow for developing self-cleaning velocities.

Sanitary sewers are lower velocity sewers and restricted for entry of storm water and silt. In sanitary sewers, the infiltration and exfiltration are restricted to minimize the flow to the treatment plant and contamination of ground water and pipelines in near vicinity. On the other hand, there is no need for the storm water to be treated and the storm water sewers need not be water tight compared to the sanitary sewers.

Binnie and Partners, and Proctor and Redforn had confirmed that separate sewers are more economic in construction and operation compared to combined sewers.

The silt, sand, bricks, stone, glass, metal, plastic and solid waste entry into the combined sewerage system along with the storm flow are the main cause of blockage of sewer lines, damage of pumping systems, and premature filling of stabilization and oxidation ponds. The sludge from a combined sewerage system is of low quality with over 95% comprising of sand, silt, glass and plastics and not suitable use as soil conditioner and rejected by farmers.
The combined sewerage system carries silt and sand to the treatment plant and only overflow water carries to river. Hence the sustainability of combine sewerage system is accounted very low compared to sanitary sewerage.

Vacuum System

Wastewater from the houses enters a vacuum pot under gravity. At a pre-determined level the valve in the pot opens and the wastewater is “sucked” into the pipeline system. A volume of air is "sucked" into the pipeline system with the slug of wastewater. The wastewater slug soon disintegrates and flows to a low point in the sewerage system, where it reforms. Subsequent flows of air push the wastewater slug through the system to the vacuum/pumping station. The vacuum pots are vented via 100mm diameter vents on each house connection. This can be a source of odour when wastewater in the pot is not evacuated for four or more hours.

The vents can be installed to prevent groundwater intrusion in the case of flood-prone areas, however they cannot be configured to exclude odours escaping. The valve is actuated by the rising wastewater level. The valves are 80mm diameter to reduce the potential for obstructions.

All wastewater is “sucked” to a central vacuum/pumping station. The pumping station is ideally located at the centre of a system with a number of suction lines. This will allow easier detection and isolation of leaks into the system.

Wastewater is deposited in a vacuum vessel at the vacuum/pumping station, and at a predetermined level conventional pumps deliver the wastewater to a treatment plant.
The vacuum pumps operate the majority of the time, however overnight with extremely low flows they would turn off with the vacuum vessels applying the “vacuum”.

Vacuum - Advantages

Capital cost can be cheaper than for conventional gravity due to:
- Pipeline construction at a minimum depth using smaller diameter pipes.
- Use of a single central vacuum/pumping station instead of multiple stations as for conventional systems.
- Elimination of some or all manholes.

The property owners have to connect their properties to a junction (boundary riser) at the lowest part of the property. They have no responsibility other than to flush wastewater into the sewer and avoid dumping toxic or harmful pollutants into the sewer. They are not permitted to discharge drainage water and storm water into the sewerage system.

With the reduction in manholes, installation of gravity pipelines at minimum depth and a sealed vacuum system, there is less potential for infiltration and inflow than a conventional gravity system (up to 50% less), hence less potential for overflows from the system.

The mixture of air and wastewater in the vacuum sewerage system maintains the wastewater in an aerobic condition reducing potential for odour and corrosion problems.

Vacuum - Disadvantages

There is some potential for infiltration and inflow (hence overflows from the system) from the gravity sections upstream of the vacuum pots. There is potential for odours from wastewater sitting in the household pipes (upstream of the pot) if the wastewater in the pot does not reach the level that opens the valve for some time, particularly as a result of absentee land owners.

Should the vacuum station fail, the entire vacuum reticulation becomes inactive, although the valves pots can provide some limited temporary storage. Leak detection is problematic as no “surface water” is present as for other systems. Leak detection may require visual inspection. Any undetected leak could result in pumping and treating groundwater with increased costs.

Pressure Sewerage Collection System

Description of the System

The pressure sewerage system has in the last 30 years experience in the United States. The system is suitable to small communities for the following situations:
- groundwater level is high
- land is flood prone
- terrain is rocky and steep
- where several pumping stations can be eliminated
- where a water-tight system is desirable
- where it is impractical to install a conventional systems.

Each property is fitted with a 630 litres fibreglass in-ground tank, 900mm diameter by 2m deep. A pump in the tank discharges wastewater from the property by a 32 mm polyethylene pipeline to a common pressure sewer in the street. The pressure sewer discharges to either a gravity sewer, pumping station or directly to a treatment plant.

The tank is located on the property in consultation with the land owner to ensure that it will collect all wastewater from the property including any future plans for development on the property.

Connection to the tank is achieved simply by inserting a pipe through the orifice provided in the tank. The tank lid is fitted with a vent to allow the tank to fill above the inlet pipe. A non-return valve can be fitted to the vent to prevent floodwater entering the tank.

An in-line semi-positive displacement grinder pump is installed in the tank. The pump grinds solids in the wastewater to 0.5mm and discharges the slurry into a pressure reticulation system. The pump can discharge to a pressure of 70m however systems are normally designed to operate at 40-45m maximum pressure. The pump turns on when a pre-set water level is reached in the tank and turns off at a lower pre-set level. A non return valve is also installed at the property boundary. Pressure mains are generally located in the nature strip and range from 50mm to 150mm diameter pipe. Polyethylene is the preferred pipe material as this can be welded and tested above ground prior to installation. This installation is free of joints, which could leak wastewater. The pressure sewer pipes can discharge into a manhole, pumping station or treatment plant, depending on the individual circumstances and the design limitations.

Pressure Sewer - Advantages

In circumstances where pressure sewer systems are suitable, cost savings can be substantial due to the elimination of pumping stations, deep excavation, and/or reduction in wastewater flows in wet weather.

Because the system is water tight there is minimal design allowance for wet weather inflow and infiltration. The design for wet weather is approximately 25% of that for conventional gravity and 50% that for vacuum systems. Therefore there is very low potential for overflow that may impact on local waterways. This also reduces the size of downstream pipelines, pumping stations and treatment plant components.

Because the system pumps much less wastewater than other systems, there is minimal energy input, therefore less greenhouse gas generation, making the system more environmentally sustainable.

Pressure - Disadvantages

There is potential for odours, particularly in holiday properties when wastewater can sit in the tank for days, if not months. This situation is the same as for conventional and/or vacuum systems where wastewater can sit in pipes on the property in the same way. If the residents leave the property for more than a weekend, they should half fill a laundry tub with water and flush the tank to minimise potential for odour nuisance. The tanks are vented via the household roof vent.

Treatment Systems

On-Site Sanitary Systems

Sanitary Sewerage systems (Collection and Treatment) become cost effective only with the savings of scale available in the areas of relatively high population density. However Public Health Policy requires that sanitation practice be followed in the areas with low population density, where Sanitary Systems are not economically feasible. In these areas, on-site

sanitation is adopted. There are several alternative systems of on-site sanitation used in Nepal, the neighbouring countries and other parts of the world. UNICEF/WHO and many other institutions made various studies and recommendations. Some of these alternatives of on-site sanitation are:

- Pour-flush toilets with two pits
- Cess pool with adequate storage for some time before empting
- Septic Tanks with Soak Pit (absorption field)
- Septic Tanks with drain to sewer
- Aerate Septic Tanks (Home Aerated Wastewater Treatment)
- Eco-san toilets with separate storage pits for urine and faece
- Public Toilet

The major disadvantages of the on-site sanitation system described above are:

- Requires separate sullage facilities
- Requires water through out the year
- Clogs frequently when bulky cleaning materials used
- Construction is difficult and expensive where ground water is high, under lying soil is impermeable
- High risk of polluting ground water
- Frequently becomes breeding ground for mosquitoes
- Smell nuisance if not properly constructed and maintained
- Concentration of these facilities at a location becomes nuisance.

Pour-flush toilets with two pits

The Pour-flush toilets are very simple low cost toilets equipped with a squatting pan without cistern and connected with a pit without lining and pit cover. These toilets are used in remote rural areas where affordability for a normal watertight toilet is low. Once the first pit is full, the connection of the pan is changed to another pit.

Cesspool

A **Cesspool** is a sealed underground tank where all the sewage from a property is stored. The Cesspool when full, at approximately monthly intervals, will need emptying by a tanker contractor, and must therefore have adequate capacity. Approval to construct a cesspool is required from the Local Authority under the Building Regulations.

Home aerobic wastewater treatment

Aerobic treatment can be a good option for homes on sites unsuitable for septic systems or in environmentally sensitive areas.

Aerobic wastewater treatment may be a good option when:

- The soil quality is not appropriate for a septic system,
- There is high groundwater or
- Shallow bedrock,
- A higher level of wastewater
- Treatment is required,
- A septic system has failed, and/or
- Athere is not enough land available for a septic system.

In communities where houses are spaced widely apart and where central sewerage systems are often not cost-effective, households use septic systems or other systems that treat and dispose of household sewage. The aerobic systems are superior quality systems than most septic systems, but cost more to operate and need more routine maintenance. However, when properly operated and maintained, aerobic systems can provide a high quality wastewater treatment that can be disposed in the surface water drainage system and help to eliminate pollution of ground water and surrounding soil and avoid smell and odor nuisance.

Aerobic systems are similar to septic systems in that they both use natural processes to treat wastewater. But unlike septic (anaerobic) treatment, the aerobic treatment process requires oxygen. Aerobic treatment units, therefore, use a mechanism to inject and circulate air inside the treatment tank. This mechanism requires electricity to operate.

Ecosan Toilets (D.R.Manandhar,N.Shiwakoti and S.kafley)

The ECOSAN toilet is based on separation of urine and faeces. Urine is collected in a separate covered chamber with storage capacity for a week and faeces collected in double vaults, each designed for storage for a period of a six-month. Faeces are mixed with other organic materials as ash, soil, leaves, grass, sawdust or any other available suitable bulking material for making compost containing NPK (1% each) and used as soil conditioner. By separating the urine, “the natural fertilizer ”, with faeces containing most of the pathogens and intestinal parasites, the bad smell and health hazard from the toilets is very much reduced. Urine is used as fertilizer as it is rich in contains with Nitrogen (1%), Phosphorus (0.1%) and Potassium (0.2%) required by the plants. The figures are based on the assumption that about 40 kg of faeces and 500 liters of urine are produced per person per year. Probably the most unfamiliar aspect of ECOSAN options is that it requires some handling, at the household level, of the toilet products. Very little amount of water that is used for toilet cleaning and anal cleansing in Nepalese context is diverted to a wetland chamber containing a filter made up of gravel and sand.

Septic Tank

In a **Septic Tank** system has advantages in that it settles and partially digests the settled sewage. However, the effluent from a correctly sized tank still contains about **70%** of the original polluting matter. Discharging the liquid into a soakaway system of say land drains after the tank, which allows the ground to treat the sewage pollutants, can further reduce this pollution. Details of how the ground may be used are contained in BS 6297. A percolation test will be required to determine whether or not the ground will absorb the liquid and remove the pollutants. If the ground strata cannot accept the liquids properly (i.e. CLAY ground is generally not suitable) then it is possible that the land drains will become blocked. The septic tank should be emptied at least annually.

Aerated Facultative Lagoons

This is easily the most common wastewater treatment methodology because it is well understood and relatively predictable. In this process, aeration is provided to a microbial consortium that in turn converts pollutants to mainly **carbon dioxide and water**. The byproducts from this biological oxidation of waste organics are additional microbes and of course residual waste compounds not biodegraded. These generate a “waste sludge” that must be disposed. High levels of COD conversion efficiency are attainable and process-

troubleshooting techniques are generally reliable. They tolerate a wide range of operational conditions and waste feed components. In addition, there are many industrial compounds that are biodegradable in an aerobic system; these are generally robust systems that recover from upsets readily with a little help. The disadvantages include the high cost of energy required for aeration; the large amount of waste sludge generated (typically 25% to 50% of the organic load treated); contamination of that sludge with industrial waste compounds; the high cost of contaminated sludge treatment and disposal. In addition, it is another process that must be supported and operated; and it is a process with which the manufacturer usually has little prior experience.

Anaerobic Wastewater Treatment Processes

"High-Tech Septic Tanks". Most food producers/processors are well familiar with anaerobic waste treatment, which employs an anaerobic (without oxygen) microbial consortium to convert organics to mostly **methane and water** with a small amount of CO2. It has long been used as a low-cost method to treat relatively clean wastes with high concentrations of organics such as juices, soft

Drinks, vegetable processing, etc.). The industrial anaerobic treatment processes in use today are little different from large septic tanks, except they include electrical instrumentation and controls to facilitate ease of process monitoring and preventive troubleshooting. The chief advantages are low waste sludge production (about 5% to 10% of the organics converted); and the low mixing energy requirement, (since there is no need for aeration energy input.) In fact, the methane produced from the influent organics is energy-rich and converts readily to electricity through a conventional generator package. Disadvantages include a relatively fickle process equilibrium (prone to upsets); intolerance of salts, sulfates, fats/oils/grease and temperature variations; poor degradation rate of solids (best with soluble organics; poor efficiencies with complex organics (best with simple sugars and starches); and the production of an odiferous and poorly-dewatered waste sludge. In short, it acts like a human digestive system and is just as disagreeable to live with when upset; and anaerobic system upsets tending to be very serious business indeed. And again, it is another process that must be supported and operated by the manufacturer; and it is a process with which the manufacturer usually has little prior experience.

Conventional Filter Bed System

In a Conventional Filter Bed System, about 95% of its polluting matter from the sewage is removed. The primary settling tank removes gross solids, the filter bed biologically treats the sewage, and the humus tank settles out the fine solids. The unit usually requires no electrical power, but a considerable fall across the site is necessary. The system must be correctly designed, at least in accordance with BS 6297, to ensure that the polluting matter is properly removed. This system requires maintenance as well as emptying tanks periodically, subject to consent from the Local Authority, and the Environment Agency. Finally, the sludge generated at an amount of 25%-50% of the organics load requires disposal.

Modern Packaged Sewage Treatment Plant

A **Modern Sewage Treatment** unit comprises of a small electrically driven packaged plant, usually all contained in one tank. The sewage is first settled to remove the gross solids and then biologically treated in a filter bed, rotating discs, or air injection, with a final settlement stage to remove the fine solids. The effluent can be discharged about 95% clean, to a land drainage system or watercourse, subject to Local Authority and Environment Agency Consents. Maintenance and emptying of the plant will be required at regular intervals.

Activated Sludge

Activated sludge is a process in sewage treatment in which air or oxygen is forced into sewage liquor to develop a biological floc which reduces the organic content of the sewage. In all activated sludge plants, once the sewage has received sufficient treatment, excess mixed liquor is discharged into settling tanks and the supernatant is run off to undergo further treatment before discharge. Part of the settled material, the sludge, is returned to the head of the aeration system to re-seed the new sewage entering the tank. This fraction of the floc is called R.A.S - Return Activated Sludge. The remaining sludge, also called W.A.S - Waste Activated Sludge, is further treated prior to disposal. Sallaghari Sewage Treatment Plant is based on this method.

Membrane Bioreactor

The membrane bioreactor is an innovative technology that offers some distinct advantages. The system is a catalyzed MBR (membrane bioreactor) which achieves biological incineration in the form of mild wet air oxidation that is ideal for high strength waste streams and sludge because it generates little or no waste sludge. The technological processes are capable of 1) treating wastewater without generating waste sludge or 2) cost-effectively destroying sludge generated by conventional processes. The core technology works by effectively integrating microbial and targeted chemical reactions to achieve total mineralization of organic waste to carbon dioxide, water and dissolved minerals. This biotechnology can also be configured for anaerobic conversion of organics to energy-rich methane and water; this variation is particularly appropriate where energy recovery is a pragmatic potential. The process is a modified thermophilic aerobic system that operates as an accelerated aerobic biological treatment process with a small sludge production similar to that of an anaerobic process; and this minimal excess sludge is destroyed with the aide of the chemical treatment step and then converted to carbon dioxide and water upon re-entering the thermophilic reactor an inherent side-stream oxidation process. (PMC BioTec). This process requires strong support and further consideration.

Constructed wetland or Reed Bed Treatment

Reed beds are constructed ponds used for tertiary treatment of diverted sludge from the wastewater treatment plants. A reed bed plant consists of different ponds. The sewage sludge dehydration and mineralisation in reed beds are a new treatment process for sludge from biological sewage treatment plants (**Prack Consult GmbH).**

A **Modern Reed Bed** sewage treatment system can successfully treat sewage to the required standards. It usually comprises of a settlement tank to remove gross solids, followed by either vertical or horizontal flow, specially prepared reed beds of specifically reared reeds. These

selected reeds have the capability to transfer oxygen from the stems to the roots where biological action purifies the sewage. The resulting effluent, which will be almost clean, can be discharged to a land drain or watercourse, subject to authorisation by Local Authority and Environment Agency provided that no pathogens are transferred to down stream land drains. The system can be operated without power, if an adequate fall is available across the site, and generally the only maintenance required is regular emptying of the tanks. Lack of adequate primary and secondary settlement tanks and removal of suspended solids very quickly clog the pipe system and filter media making the reed bed plant redundant.

This system is normally undertaken in a packaged type of sewage treatment plant, and **the reed bed is used to act as a tertiary treatment module**. Any excessive storm flows in the sewage into the works, by-pass the main treatment unit (to avoid hydraulically overloading it) and as they are usually considerably weaker strength, these excess flows are then treated in the reed bed (**Johnston Smith Consulting**). The Reed bed treatment plants constructed in Nepal is used as secondary treatment or some times as primary treatment without using conventional treatment procedures. Consequently, the filter media and the pipelines are clogged, and during monsoon period the effluent overflows to downstream drainage without treatment. These treatment plants may require further consideration and approval from Environmental Agency. The constructed wetland facility is designed to treat effluent from the Wastewater Treatment Plants as part of a strategy for meeting tougher water quality standards for sewage treatment facilities (Arizona Water Authority). Disposal of sludge and solids is a major problem that is common to other treatment methods.

Appendix-4: Sanitary Sewerage Services

The services related to Sanitary Sewerage are briefly described as follows based on the category of facilities. These services very effectively outsourced to private sector enterprises.

Inventory and condition assessment – The most important part of the Sanitary Sewerage Services would be to collect the data and information on the existing system and prepare an As-built plan that will provide guidelines to plan and execute effective operation and maintenance services. The plan, if not available, could be prepared by inventory survey, physical assessment, Infiltration and Inflow, Flow conditions: Blockage, Roots, deposits and Structural conditions, Effluent Quality evaluation.

Sewer system evaluation surveys – This survey will be useful for determining the adequacy of the existing system and need for extending and capacity building, and will be based on the inventory and physical assessment**.**

Sewer House connection Inventory surveys – This survey will identify households with various categories of sewerage and drainage connection, and facilitates to determine the appropriate fee levels for sewerage house connection. The appropriate charges for sewer connection will provide motivation to the house owners to adopt appropriate connections based on system available and their choice of wastewater treatment within their premise.

Removing Blockage by Roding - Use of extending rod to remove solid sediments in the sewer lines and manholes, removing blockage. The rod is frequently fitted with auger head and cutting blade, and motorised. This operation is frequently followed with water jetting.

Sewer Jetting - Use high-pressure water combined with specially designed hoses and nozzles to break up tough soap, grease, and sludge blockages. These materials, once broken up, are then flushed out of the line. Jetting can also remove many blockages that traditional methods cannot, including leaf blockages in down spouts. One of the interesting job is to remove silt, sand, brick stones and other solid waste from the sewers.

Root Removal - Use mechanical cable machines and special cutters to remove root blockages in the sewer pipes. Once the blockage is removed, the sewer line can then be inspected with CCTV system to determine where the roots are entering the pipe and what can be done to prevent them. Several options are available for keeping the pipe free of roots, including **lateral lining**, chemical treatment, or preventative maintenance plans.

Pipeline Inspection - The inspection of the inside of sewer lines by utilizing colour video technology. This service is especially useful in determining if the blockage was completely removed and if the pipe is cracked, broken, or collapsed. This allows the condition of the pipe to be reviewed by executives and community members at a later time.

Leakage Test - The inspection is followed by leakage test by filling the sewer section between two adjacent manholes. The sewer section is blocked at the two ends and the

remaining part is filled with water and observation is made whether the water level is maintained or dropping. This will guide to determine the infiltration and exfiltration from the sewer lines.

Locating - By using a sonde (radio transmitter) that is attached to a sewer cable or camera head, a signal is sent from inside the pipe to a receiver. This receiver is operated by a trained technician and can tell the technician the location of the pipe under the ground. It can also calculate the depth of the pipe. This information is useful when it is necessary to pin-point a damaged section of pipe, or when trying to connect a new pipe into an existing pipe.

Planned Maintenance Programs - A maintenance program, based on the practical problems encountered or visualised before hand from the experience, will be very important.

Sludge Removal – *Removal of sludge from the stabilisation ponds and lagoons is one of the tough jobs that require special attention and approach.*

Removal of Plants - Removal of Green plant growth and algae from oxidation ponds is also important job that help to keep the treatment plants functional.

Harvesting of Reed Plants – Removal of Reed plants from the Reed Bed Treatment plants at regular interval when matured is required to allow removal of dissolved solids and nutrients from the affluent from wastewater treatment plants before release to wetland marshes or river system.

Operational Guidelines and regulations – Preparation and Updating of operational guidelines of Sewerage system including Treatment Plants

Appendix 5: Policy Action Matrix

Constrains	Recommendation	Activities	Measurable Indicators	Responsible Organisation	Time Frame
General Action Matrix					
Lack of Institutional Framework	Establish an Exclusive and dedicated organisation	- Establish and Empower Ad Hoc NCUWM, and Local Councils - Establish Environmental Audit Organisation - Empower Civil Society for performance monitoring;	Meetings take place, Organisations established	Council of Ministers, NPC	Immed iate
Lack of Legislative and Regulatory Framework	Develop Comprehensive Policies, Framework	- Review existing frameworks (Acts, Rules, Regulations) for gaps and amend - Develop procedures for consensus building - Establish Supportive Committees	Documents prepared, Committees formed	NCUWM,	Long Term
Lack of Vision, Goal and Objectives	Develop Vision, Goals, Objectives and Purpose	- Carry out Objective analysis - Consolidate Purpose - Recognise UW as important Infrastructure - Develop Consensus for Adoption of Community/ Producer Responsibility Approach	Documents prepared	NCUWM, Stakeholders	Immed iate
Lack of Comprehens ive Approach	Review existing Acts and Documents, Regulations	- Define Roles and Responsibilities - Develop Financial and Investment Framework - Develop PPP Models - Develop Manuals of Procedures and Procurement Framework - Update Implementation Strategy - Establish Data and Info Centre	Documents prepared	NCUWM, Stakeholders	Long term
Lack of UWM Fund	Review Rules and Regulation	- Carry out Feasibility Study - Identify potential sources - Carry out Studies on Tax collected - Transfer contribution from other relevant funds -	Document prepared	NCUWM	Immed iate

Constrains	Recommendation	Activities	Measurable Indicators	Responsible Organisation	Time Frame
Lack of capacity to develop PPP	Develop Annual Programs for PPP	- Carry out Studies on Opportunities for PPP Development - Carry out Training to Stakeholders - Outsource jobs through PPP - Support Awareness Building, Information Dissemination, Education, and Empowerment	Performance Evaluation	NCUWM	Interm ediate
Lack of Comprehens ive Marketing Strategy	Develop Marketing Strategy	- Carry out Marketing of Waste Products - Develop Entrepreneurship - Develop Economic instruments for production of clean and high quality waste materials - Outsource Waste collection jobs	Periodic Survey and Reporting Documents Prepared	NCUWM/ Local Councils	Long Term
Motivation, Incentives	Introduce Motivation for Good Practices	- Develop Economic Schemes for Motivation, Incentives and Awards - Support unsolicitated, Innovative, creative Ideas and R&D	Documents prepared		Interm ediate
Sub-Sector Wastewater Management					
Lack of improvemen t in WWM	Develop Level Plans and Programs	- Evaluate Potential for PPP in WWM in 5 Municipalities	Documents and Reports	NCUWM/ Local Councils	Immed iate
		- Explore Unbundling of 3 WW Plants in KV from Melamchi Project (Dhobighat, Sallaghari and Hanumanghat WWTP)	Documents and Reports	NCUWM/ Local Councils	Immed iate
		- Support WWTP Development by Private Sector	Documents and Reports	NCUWM/ Local Councils	Interm ediate
		- Support Entrepreneurship for Sewerage System operation and Business for sludge reuse and WWM	Enterpreneurship functioning	NCUWM/ Local Councils and Private Sector	Interm ediate

Appendix 6- Roles and Responsibilities

S.No.	Sector	Roles and Responsibility
1.	National Council	o o Coordination with Central Government and Stakeholders, o Coordination for developing better understanding and Consensus Building o PPP Development o Coordination for sharing knowledge and better experience o Guidance for Policy change, updating legislation and Regulation, o Preparation of common plans and programs o Support Creating Proposed UWM Fund o Guiding the preparation of Implementation Strategy and Manual of Procedures, o Supporting for Capacity Building and Technology Transfer o Guiding the Partnership and Enterprise development through Franchising, o Support for Studies, Research, Market and Development**,** o Creation of Data, Information Bank and Knowledge Centre, o Facilitation for Clearance of Documents, Procedures, Plans and Programs, o Facilitation for Motivation to Stakeholders, o Catalytic Support to Executive Agencies, o Surveillance, Monitoring and Evaluation
2.	Local Councils	o Coordination with National council and Municipality, o Regulation and Facilitation, Providing Guidance for Program Development, Partnership Development, Environmental Monitoring, Motivation to Local Stakeholders, Procurement of Services, Outsourcing of Jobs, Support Resource mobilisation, Support Private sector Initiatives o Regulation and Facilitation of Implementation of Plans and Programs, o Protection of Citizens' Interest,
3.	Parliamentary Committee	Pursue for continuous support for reforms and updating Policy, Legislation, Rules and Responsibility, Advocacy for effective implementation of Policies, Plans and Programs,
4.	Environmental Audit Committee	Follow up and providing guidance for fulfillment of obligations under Policies, Plans, national and international commitments
5.	Dispute Resolution Board and Judiciary	Reduction of dispute and conflicts, developing understanding and consensus, mediation, fair judgment
6.	Surveillance Committees	Follow up of performance of Authorities based on agreed Plans and Programs, Policies, Legislation, Rules and Regulations
7.	Advisory Committee	Advise from time to time as per requirement, Advocacy for appropriate decision making based on agreed Policies, world

		trends and innovative ideas
8.	The formal private (commercial) sector	o Potential Waste Management function contractors or industrial entrepreneurs, o Mobilizing Capital Resources, Technology and Knowledge o Pursuit for higher profits through application of WM principles, o Promotion of UWM as part of their Social and Corporate Responsibility, o Pursuit for higher profits through re-engineering processes, redesigning products, o Supporting Innovative Studies, R&D, Motivating employees, and o Taking other measures bringing reforms in UWM Policy of the companies.
9.	The informal private sector	Individuals, small entrepreneurs, and micro-enterprises- potential functional small contractors, R&D, Innovative Studies
10	Community based organizations (CBOs) -	Advocacy for idealistic goals, working for their own welfare, working as watchdogs and Surveillance of Sectoral Performance, Community Motivation
11	Non-governmental organizations (NGOs) -	Advocacy for Organizational Ideals, Employment generation, Community Motivation, Surveillance of Sectoral Performance,
12	Households	Active Participation in UWM and Advocacy for community goals
13		o
14	Individuals	Pursuit for employment, Advocacy for ideal goals and support UWM activities

Appendix 7- List of Participation of Stakeholder Meetings

Venue: Nepal Engineers' Association
Date: July 21, 2006 Time 4-6 PM

Discussion Initiator and Paper Presentor: Er. Badan Lal Nyachhyon, 98510 25400
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Appendix - 8: Suggested Further Studies

The consultation with the stakeholders, professional groups and EPN Advisory committee and workshop has suggested for a score of supplementary studies for enhancing the effectiveness of the policy paper and to rationalise the proposed activities with pragmatic approach and actions. The suggested further supplementary studies are listed below:

Need for appropriate institutional framework and most appropriate model – The proposed National Council for Urban Waste Management and Local Council are recognised as very good concept of institutional arrangement appropriate for Wastewater Management and eliminates duplication of efforts. The Central and local level Waste Management Council would be instrumental to play vital role in the policy formulation, monitoring and coordinating roles. But the implementation responsibility will be vested on the existing agencies. It would be very important to consider for the capacity building of these existing institutions based on the principle of " Centralised planning and decentralised implementation." Further studies will be required to crystallise the institutional structure of the central and local agencies and consolidate the definition of the roles and responsibilities and harmonising with the mandate of the proposed councils.
The study would also analyse the resources required to support the functions of the councils and executing agencies, human resources, qualification and recruitment process of the human resources.

Investment and Operational Expenses – The Expenditure patterns incurred in the development of existing Sanitary Sewerage (Separate and Combined Sewers and Treatment Plants) and their operation and maintenance would be the fundamental for assessment of the sustainability for the proposed institutional arrangement with National council, Local Councils, Central policy making agencies and local executing agencies. It would be very essential to base the studies on the actual structure of investment and operational expenses incurred so far in existing sewerage systems. The proposed financial studies will be instrumental to justify the rationale to implement the new proposed structures of council.

Appropriate model of PPP/NGO/CBO and Incentive Schemes - Private sector would not be interested if there were no profits, but to the contrary they could be attracted through provisions of attractive incentives. Thus, a public private partnership model related with incentives schemes may be designed and proposed as a preferred model for typical Nepalese environment. The model may be modified to suit the local needs. The incentive scheme may be based on the environment merits of wastewater management and reduction of cost to the consumers and the local governments and encouragement for introduction of waste management at source that will reduce cost to the government.
Autonomous Authority for river pollution control – The state of rivers in Nepal is very miserable particularly because of lack of owner of the river system. The rivers are state property and do not belong to a particular department or municipality. Hence the pollution of the rivers is a free style action. If pollution control of rivers is of some concern, it is obvious that there is a need for nominating an independent and exclusive authority who will exhibit he ownership and takes charge to protect its environment and work towards conservation.

Specific Recommendation for Reforms of Existing Policies, Laws – The proposed Policy Reform recommendations have effect on various existing Law, Rules and Regulation. It would be important to make appropriate and timely amendment of the exiting Laws to

introduce the Social and Corporate responsibilities for consideration of Urban Waste Management including Wastewater Management and to introduce the Urban Waste Management Fees from the waste generators and Polluters.

Urban Waste Management Fund (Polluters should pay more) – The structure of the Urban Waste Management fund will guide the efficiency and sustainability of the proposed NCUWM and the effectiveness of the proposed actions. A detailed study of the structure of the proposed fund would be paramount for undertaking the proposed actions.

Generating More Water and Rain Water Harvesting– The most common method of eliminating pollution is to dilute the contaminants with air or water. Since water is a scarce commodity, various means of conserving water and by that action saving more water would be fundamental. Appropriate methods of conserving water would be a subject of concern. This may include study on behaviour change required for conservation of treated water. Equally important will be the subject of Rain Water Harvesting to be studied in depth to ascertain the derived economic benefits and appropriate investments.

Economic Return of separate treatment of Black and Grey Water - Based on the quality, wastewater is categorised into Black water (foul water) from toilet, Grey water (sullage water) from kitchen and bathrooms and rainwater (surface drainage) from roof terrace or courtyard. The treatment of categorised wastewater may be carried out differently since the scale of difficulty is different. The treatment of grey water or rainwater may be much more easier for treatment and for certain use may not be required. For example, grey water may be directly used for watering gardens or reuse for flushing toilets whereas black water requires full-fledged treatment for removal of e-coli bacteria. Wherever appropriate, encouragement shall be given for reuse of grey water and rainwater, and recycling of black water based on the affordability and economic return.

Technical Audit and Performance Evaluation of Reed Bed Plants – There are over 12 operating Reed Bed Treatment Plants in Nepal and more plants are in design stage under Urban Environment Improvement Project, but the technology is still in Pilot Phase. It is suggested that it may be wise to make a detailed performance evaluation study and technical Audit of these plants and derive lessons for replication and use in future projects prior to further execution and implementation in the proposed towns. The RBTT shall be limited for use at tertiary treatment level only.

Areas of natural purification – The workshop and meetings suggested for a brief study on the areas of natural purification of wastewater effluent. This may be useful for enhancing the benefits from wastewater facilities.