6

Waste Management

Solid waste and wastewater are the two most visible environmental nuisances and major causes of pollution in the urban areas of Kathmandu Valley with consequences beyond the urban limits. Managing solid waste and wastewater in Kathmandu has become a daunting task as urban areas have grown haphazardly without provisions or plans for appropriate infrastructure and services in these sectors: a typical trend is that first housing/ settlements/ urban areas expand without any plan and then infrastructure and services are demanded. Theoretically, this should be the reverse. Urban expansion should follow plans and provision of infrastructure. Consequences of unplanned haphazard urban growth are that providing infrastructure and services becomes complex and difficult; infrastructure and services provided become inefficient and ineffective; and pressure on the existing infrastructure and services increases beyond their capacity as they were designed for certain conditions/limits.

Traditionally, solid waste and wastewater generated in Kathmandu Valley's urban areas were re-used/ re-circulated in agricultural activities in nearby rural areas. This was possible as the waste was mostly organic and urban settlements were surrounded by agricultural fields. But this is no more the case and this waste is polluting the environment. The DPSIR analysis of waste generation is presented below.

Drivers

Centralisation and rapid urban growth

The main driving force behind rapid urban growth in the Kathmandu Valley is centralisation. As power, wealth, and services such as education and health facilities, infrastructure, and international linkages have been historically concentrated in the Kathmandu Valley, it has attracted people from all over the country. Kathmandu Valley is the most urbanised region in Nepal. About 60% of its population reside in urban areas; and this was only 47% in 1980. Over the years not only the urban population, but also the urban growth rate has increased, e.g., the urban growth rate was about four per cent in the 1970s and over five per cent in the 1990s (Sharma 2003). Some studies indicate a rate as high as seven per cent or more in the case of Greater Kathmandu[7]. The urban population of Kathmandu Valley has increased five-fold since 1950. Increased population generates increased waste, both solid waste and wastewater.

Pressure

Unplanned and haphazard urban expansion

Although various plans were prepared for urban development of the Kathmandu Valley, urban areas continue to grow haphazardly and without appropriate planning and infrastructure such as water supply and sewerage systems, solid waste management facilities, and services. Properly planned urbanisation can play a positive role in promoting economic activities, as well as in promoting conservation of resources to reduce pressure on land resources. However, haphazard and unplanned urbanisation leads to many environmental difficulties such as those presented by solid waste and wastewater management.

Change in consumption patterns and living standards

The consumption patterns and living standards of the urban dwellers of Kathmandu Valley have been changing gradually over the years. Availability and use of modern facilities, such as flush toilets, and changes in lifestyle/consumption patterns have contributed to i) producing more waste and ii) changing the composition of waste, e.g., plastics in solid waste and detergents/ chemicals in wastewater. Solid waste and wastewater generated in the urban areas of Kathmandu Valley are more polluting now than they were five decades ago.

[7] Kathmandu Metropolitan City and Lalitpur Sub-metropolitan City together are referred to generally as Greater Kathmandu.

Commerce, business, industry, and services

Over the last thirty years, Kathmandu Valley has experienced significantly higher commercial and business activities than other parts of the country. Services, such as hospitals, have expanded. The World Conservation Union (IUCN 1999) reported that about 51% of the total industries in Nepal with employment of more than 10 persons are located in Kathmandu Valley. Balaju, Patan, and Bhaktapur are the three industrial estates in the valley: out of 2,174 industries in the valley, only 202 industries are operating inside the industrial estates. Industries have been established in a haphazard manner in the absence of land-use planning and industrial zoning. The main areas in which industries are concentrated are the central and southern part of the valley, Balambu-Satungal, Satdobato-Godavari, Koteshwor-Bhaktapur, and Kalanki-Thankot. There are over 40 types of industry in the valley, including carpet weaving, garment manufacturing, washing, dyeing, dairy products, bakeries, animal feed, breweries and distilleries, pharmaceuticals, plastic products, and chemicals. About 80% of the industries scattered throughout the valley have the potential to affect land, water, and the environment. The business, commerce, services, and industries generate waste, and this is quite different from domestic waste.

State

Municipal solid waste

Municipal solid waste generation rates – Solid waste generation rates vary depending upon living standards, livelihood practices, and consumption patterns. Studies carried out in the past suggest that the waste-generation rate has changed over the years in Kathmandu's urban areas (Table 6.1). The current estimated generation rates of municipal solid waste in five municipalities of the Kathmandu Valley are given in Table 6.2.

Amount of Municipal Solid Waste – The amount of municipal solid waste generated can be estimated on the basis of unit rates and population. The five municipalities generate daily approximately 435 tons of solid waste, of which more than 70% comes from KMC. An estimated amount of municipal solid waste generated in the five municipalities of Kathmandu Valley is shown in Table 6.3.

Table 6.2: **Recent estimates of waste generation rates in five municipalities (kg/person/day)**

Municipality	IDI Pvt. Ltd. 2004 (2003 survey)		Nippon Koei 2005 (2004 survey)	
	Household rate	Municipal rate	Household rate	Municipal rate
Kathmandu	0.39	0.52	0.250	0.416
Lalitpur	0.54	0.72	0.285	0.416
Bhaktapur	0.39	0.52	0.120	0.316
Madyapur Thimi	0.11	0.15	0.160	0.266
Kirtipur	0.34	0.45	0.150	0.266

Note: IDI 2004 assumes the same multiplying factor (1.333) to calculate municipal waste generation rates from the household rates. Nippon Koei 2005 uses different multiplying factors in each of the five municipalities.

Table 6.3: **Waste generation in five municipalities (tons/ day)**

Municipality	Generation in 2004	Collection in 2004	Projected generation 2015
Kathmandu	308.4	250	547.9
Lalitpur	75.1	52	135.4
Bhaktapur	25.5	19	46.2
Madhyapur Thimi	14.3	5	27.8
Kitipur	11.6	4	18.1
Total	**434.9**	**330**	**775.4**

Source: Nippon Koei 2005

Table 6.1: **Municipal waste generation rates in Kathmandu over the years, kg/person/ day**

Study	Year							
	1978	1988	1990	1993	1998	1999	2003[a]	2004[b]
Lohani and Thanh	0.25							
GTZ		0.4						
Rai			0.565	This estimate appears to be high compared to the trend shown by other studies.				
Khanal				0.46				
Mishra and Kayastha (vary depending on population size: 0.4 kg/person/day from 100,001 to 400,000 people; 0.5 kg/person/day for more than 400,000 people)					0.25 to 0.50 kg/person/day			
RESTUC						0.48		
IDI Pvt Ltd							0.52	
Nippon Koei et al. (CKV study)								0.416

Source: Various sources quoted in UNEP 2001 and [a]IDI 2004, [b]Nippon Koei et al. 2005

Composition of Municipal Waste – Composition of municipal waste changes over time as consumption patterns change. Various studies carried out since 1976 indicate that around two-thirds of the municipal solid waste generated in Kathmandu Metropolitan City is organic: this has remained relatively unchanged over the years. The amounts of plastic, paper, metal, and textiles in municipal solid waste have changed significantly: plastic increased from less than one in 1976 to more than 16% in 2004; paper increased from around six to around nine per cent; metal decreased from about five to less than one per cent; and textiles decreased from around six to around three per cent (UNEP 2001; CBS 2005).

Electronic waste such as parts of mobile phones, computers, televisions, and so on are new constituents of solid waste in the Kathmandu Valley: solid waste management workers report these waste products although no data are available at present regarding their share.

The recent composition of solid waste in the five-municipalities is compared in Table 6.4 below.

Municipal solid waste management

Figure 34 shows the institutions involved in solid waste management in Kathmandu Valley's urban areas and Figure 35 those involved in wastewater management. At the operational level, the municipalities are the main bodies responsible for solid waste management on a daily basis. They spend significant amounts (typically in the range of 20 to 25% of their total expenditure) on solid waste management and have established separate sections within their institutions to deal with waste.

A significant number of non-government organisations (NGOs), community-based organisations (CBOs), and the private sector are involved in solid waste management activities in the five municipalities. They

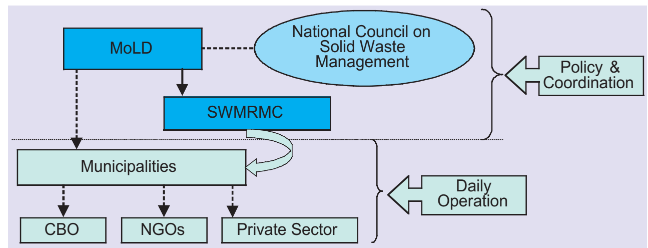


Figure 34: Institutions and their roles in Solid Waste Management (SWM) in Kathmandu Valley

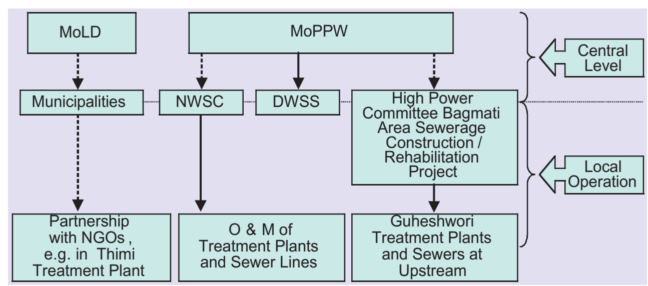


Figure 35: Institutions and their roles in wastewater management in Kathmandu Valley

Table 6.4: **Composition of municipal solid waste, % of waste (by weight)**

Content	Kirtipur	Kathmandu			Lalitpur		Bhaktapur	Thimi
	2000	2002	2003	2004	2003	2004	2003	2003
Organic	74	69	69	66.00	54.0	67.5	70.16	70.1
Paper	3	9	9	10.40	9.9	8.8	2.37	4.9
Rubber	1	1	1	0.24	-	0.3	0.05	0.55
Leather	2	n.a.	n.a.	0.24	-	-	-	-
Wood	0	1	1	-	-	0.6	-	-
Plastic	9	9	9	16.30	9.49	11.4	3.23	8.25
Textile	6	3	3	3.58	2.72	3.6	1.69	2.31
Ferrous metal	-	1	1	0.84	2.03	0.9	0.07	0.25
Inert	-	-	-	1.01	0.03	-	21.05	12
Glass	1	3	3	1.38	12.8	1.6	1.33	1.29
Other	4	4	4	0.04	7.54	5.3	0.05	0.19
Medical waste	-	-	-	-	1.3	-	-	0.2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Average collection				65.20	38.2		51.28	47.18

Source: IDI 2004 and Kathmandu Metropolitan City, Lalitpur Sub-metropolitan City cited in CBS 2005 play an important role in waste collection (including door-to-door waste collection), in promoting composting by households and the community, as well as in running awareness campaigns. According to informal estimates, around 58 such organisations are active in the urban areas of Kathmandu Valley. They charge about NRs 100 per month per household for door-to-door collection of waste (charges vary from about NRs. 50 to NRs. 200).

The Solid Waste Management and Resource Mobilisation Centre (SWMRMC), established under the Solid Waste Management and Resource Mobilisation Act, used to be the key central agency responsible for solid waste management. However, the Local Self-Governance Act 1999 allocated most of the operational-level functions of solid waste management to the municipalities, and SWMRMC under the MInistry of Local Development (MoLD) is now responsible for developing policies, identifying and developing landfill/ waste disposal sites, and coordination functions. Discussion about roles, responsibilities, and mandates of municipalities and the SWMRMC has been going on since the enactment of the Local Self Governance Act (LSGA). Current practices of municipal solid waste management in urban areas are summarised below.

Street sweeping. Street sweeping is usually carried out by municipal or private sector or NGO employees, usually in the morning (5 to 7 a.m.). In some areas, sweeping is also carried out later in the day (around 1 p.m.) and at night (7 to 10 p.m.).

Collection and transport. The waste deposited on the roadside or on the ground is picked up and transported by municipality vehicles (or recently and to a limited extent by the private sector). The waste is either transported to a transfer station or directly to the final disposal point.


Source: A. B. Manandhar, SEED-Nepal

Solid waste collection

Door-to-door collection. NGOs and the private sector have recently started door-to-door collection services in limited areas. Tricycles or rickshaws are used and households are charged (around Rs 100/ month) for the service. There are around 58 NGOs/ private sector organisations involved in solid waste management.

Composting. Household composting is promoted by distribution of compost bins (100-litre bins). NGOs/ CBOs manage community composting at different locations. Vermi-composting is also being promoted. There is no large-scale or well-managed composting facility, except in Bhaktapur. The composting facility in Bhaktapur receives about three tons of waste/day, and the composting method used is simple, manual open-field heaping: this has been in operation for over 20 years, although it encounters minor management difficulties at times. The composting facility at Teku (capacity 15 tons/day) has been closed since 1990. The private sector has shown an interest in setting up a compost plant: this, however, has not progressed because no site is available and low priority is given to this approach.

Reuse and recycling. Metal, glass/ bottles, plastics, and paper are the main items reused/recycled. Independent collectors collect metal and plastic from houses and sell them to scrap shops. Informal estimates suggest that there are around 250 scrap dealers in Kathmandu Valley. A total of about 116 tons of recycleable material is exported daily from the Valley, excluding bottles, feathers, and waste oil from automobiles (Nippon Koie 2005). Bhaktapur Municipality operates a paper-recycling facility. NGOs/ CBOs are also involved in small-scale paper recycling.


Source: ENPHO

Waste at Teku station

Source: Drona

Bin composting

Source: ENPHO

Okharpowa

Source: ENPHO

Sisdole compaction

Final disposal. Until recently, solid waste from Kathmandu and Lalitpur used to be disposed of along the banks of the Bisnumati and Bagmati rivers. Since June 2005, solid waste from Greater Kathmandu is being transported to the Sisdol landfill site for final disposal. This site also faces public opposition periodically. The long distance, about 25 km, makes transportation to the site costly. The Sisdole landfill site has been designed for three years: about half the time is over. Therefore, it is of some urgency to develop a long-term integrated plan and facility (ies) for managing and disposing of solid waste. Bhaktapur used to dump the waste at the Hanumante River dumping site: at present its solid waste goes to different locations on the banks of rivers and is also used for filling low-laying spots. Kirtipur and Madyapur Thimi have no landfill sites: solid waste collected in Kirtipur is dumped openly on the western bank of the Bagmati River and that collected in Thimi is disposed of by dumping it in open spaces and also along the banks of local rivers.

Industrial solid waste

Balaju Industrial Estate, Patan Industrial Estate, and Bhaktapur Industrial Estate are the main sources of industrial solid waste in Kathmandu Valley. These three estates generate 103,910 kg of solid waste a month (Table 6.5)

There is no systematic approach to managing the solid waste generated by the industrial estates or from industrial enterprises. Enterprises employ sweepers to clean up the premises. The waste is collected in sacks or drums and dumped into pits or backyards or in open spaces, or else it is burned within or outside the premises of the enterprise. The waste is also mixed with municipal waste. Not enough effort is being made to recycle the waste, apart from selling off scrap metal, although around 50% of the waste generated in the industrial estate is recyclable.

Medical waste

Categories of medical waste – The National Health Research Council (NHRC) classifies waste generated in health care institutions (HCIs) into three types: general, hazardous, and sharp. A survey of six hospitals in Kathmandu showed that the proportions of general, hazardous, and sharp in the hospital waste are typically 77, 15, and 8% (Table 6.6). The higher percentage of hazardous waste is present in the bigger HCIs.

Table 6.5: **Waste generated at the industrial estates in Kathmandu Valley, kg/month**

Waste type		Balaju I.E.	Patan I.E.	Bhaktapur I.E.	Total
Bio-degradable	Food/ kitchen	2,500	500	500	
	Agriculture	10,000	2,000	500	
	Sub-total	*12,500*	*2,500*	*1,000*	*16,000*
	%	26.04	5.0	16.7	15.4
Recyclable (not currently recycled)	Paper	10,000	200	1,000	
	Plastic	5,000	2,300	3,000	
	Tin/ iron/ steel	1,300	2,000		
	Wood	3,000	30,000		
	Milk products	200	-		
	Other			20	
	Sub-total	*19,500*	*34,500*	*4,020*	*58,020*
	%	40.63	69.1	67.0	55.8
Non-recyclable	Rubber/ leather	9,500	-	n.a.	
	Inert material + dust	5,000	12,800	960	
	Sub-total	*14,500*	*12,800*	*960*	*28,260*
	%	30.21	25.6	16.0	27.2
Other waste	Hazardous	500	-	n.a.	
	Medical	500	50	n.a	
	Chemical	500	50	20	
	Liquid waste	-	10		
	Sub-total	*1,500*	*110*	*20*	*1,630*
	%	3.13	0.2	0.3	1.6
	Total	**48,000**	**49,910**	**6,000**	**103,910**

Key : I.E. = industrial estate
Source: Based on Nippon Koei 2005

Table 6.6: **Amount and type of waste generated by selected hospitals (kg/day)**

Hospital	Waste type, kg/day (%)			Total, kg/day
	General	Hazardous	Sharp	
Bir	521 (74%)	120 (17%)	60 (9%)	701
Om	221 (83%)	31 (11%)	16 (6%)	267
TUTH	456 (74%)	105 (17%)	53 (9%)	614
Patan	304 (74%)	70 (17%)	35 (9%)	410
Prasuti	251 (86%)	26 (9%)	16 (5%)	292
Total	**1,752 (77%)**	**352 (15%)**	**179 (8%)**	**2,282**

Source: Based on Rawal 2004 and Basyal and Pokhrel 2004 cited in Poudel et al. 2005.

Quantity and rates – There are approximately 61 health care institutions (HCIs) in the Kathmandu Valley with 3,905 beds (Nippon Koei 2005). Surveys carried out in 1997 and in 2000 indicate that rates of generation of Health Care Waste (HCW) as well as health care risk waste (HCRW) in HCIs have increased: in 1997[8] average rates of generation of HCW and HCRW in Kathmandu HCIs were 0.54 kg/patient/ day and 0.16 kg/ patient/ day respectively. In 2000[9], these rates were found to be 1.7 kg/ bed/ day and 0.48 kg/bed/day. By considering the occupancy in HCIs, ENPHO estimated the total infectious waste generation in the Kathmandu Valley in 2000 to be 1,312 kg per day. Table 6.7 presents waste generation at selected health care institutions in the Kathmandu Valley.

Handling of waste in HCIs – Only a limited number of HCIs carry out segregation and treatment of waste. Larger-sized HCIs in Kathmandu Valley use colour-coded bins to segregate waste at the source. However, there is no uniform colour coding system. Although the National Health Research Council (NHRC) categorises three types of waste, some HCIs use two different coloured bins, some three, and some even five. Waste from these bins is typically collected once or twice a day (except in some private nursing homes): the number of bins and frequency of collection are usually inadequate, resulting in complete filling/ overfilling and even spillage of waste. Waste thus deposited is transported either in plastic bags or in open buckets. In many cases, the waste accumulated in separate bins is mixed either

Table 6.7: **Waste generation rate and amount of waste generated at selected hospitals**

Hospital	Waste (m^3/d)
Infectious diseases, Teku	NA
Nepal Eye, Tripureshwor	11
Bhaktapur Hospital	9
TB Hospital, Thimi	7
Ayurvedic	3
Patan	60
Mental	6
Maternity	66
Kanti Bal	40
Birendra Police	NA
TU Teaching	80
Bir	93
Central Veterinary	2

Source : Tuladhar, Bhusan cited in CBS 2005

[8] Surveys conducted in 11 HCIs in Kathmandu.
[9] ENPHO

Source: Lalitpur Sub Metropolitan

Waste pickers collecting medical waste with other waste

in the process of removal from the bins, or during transportation from the point of generation, or during collection in the storage area; and hence making the segregation at source meaningless. The waste storage area in some HCIs is an open space in the premises or at the back of the hospital (except for Patan hospital which has assigned a 'dirty' room in each unit as a waste storage area).

Final disposal of HCI waste – In a few large HCIs, incinerators have been installed for infectious/ hazardous waste. However, many of these are not proper incinerators (they are rather burning chambers) as they operate at low temperature and have low-stack height. Proper incinerators require a lot of investment and operating costs as well as skilled human resources. Incinerators are difficult to operate and maintain, and there is also public opposition to them as they could emit objectionable gases and fumes. Incinerators installed by KMC at Teku could not be used because of public opposition. In recent times, autoclaves have come into relatively wide use in HCIs.

In many cases, infectious waste and sharp objects as well as general waste are disposed of in municipal containers – turning the municipal waste into infectious/ hazardous waste.

Municipal wastewater

Quantity of municipal wastewater. Many factors influence the volume of wastewater generation: the volume of water available for domestic and commercial use, the living standards of consumers, and the types of commercial establishment, e.g., hotels, restaurants, offices, schools, and shops. In urban Kathmandu, residential and commercial areas are not clearly separated, making it difficult to separately quantify the volumes of wastewater generated from these sources. Potential domestic wastewater generation in Kathmandu's urban area in 2000 was estimated to be 124 million litres per day (Mld) , of which only about 47 Mld (about 38%) was collected through the sewerage system (Metcalf and Eddy 2000). The volume of wastewater is likely to increase after the Melamchi Water Supply Project starts supplying water in adequate amounts. The capacity of the existing sewerage system to carry wastewater in future is questionable.

Sewers and drains. Several agencies are involved in construction of storm-water drains and sewers in the urban areas of Kathmandu: the Nepal Water Supply and Sanitation Cooperation (NWSC), Municipalities, Department of Water Supply and Sewerage (DWSS), local communities, the 'High Powered Committee' for Implementation and Monitoring of the Bagmati Sewerage Construction/Rehabilitation Project, and the Department of Roads (DoR). Their work is, however, uncoordinated and unplanned. Sewer construction by municipalities has increased recently, and the sewerage system is expanding significantly (although exact data are hard to find): but all these activities are not well thought out and do not consider treatment aspects. The existing sewers and drains are obviously overloaded; particularly during monsoon when many of them have to cope with storm water although they are not even designed for rain water or for extended areas.

Most of the sewers constructed in Kathmandu Valley by NWSC (which is estimated to be 200 km) are designed as gravity sanitary sewers[10], whereas the DoR constructs roadside drains for surface runoff. The communities and municipalities do not generally differentiate between sanitary sewers and storm drains. In practice, all sewers and drains carry sewage and storm water, as well as industrial effluents if there are industries in the locality, as there is no control and coordination. One example is that the sanitary sewers constructed under international development aid- (IDA) funded projects and storm drains constructed by the Kathmandu Municipality under the ADB-funded project are currently carrying both sanitary sewage and storm water, thus functioning as combined sewers which was what they were designed to do. Outlets from households are also connected to the DoR-constructed road drains and the DoR also connects road drains to sewers. As

[10] Pumping introduced at Sundarighat and in Bhaktapur could not be operated satisfactorily.

there is no zoning, technicians find it difficult to size/ design the capacity of sewers/ drains – as a consequence, the size they select may be inappropriate and the sewers/ drains become overloaded.. There is no coordination between agencies and the provision of sewers does not follow an overall development plan. Many of these sewers may have to be replaced under a well-engineered master plan (Nippon Koei et al. 1999).

Maintenance of existing sewers is very poor: most of the sewers, including the interceptor mains and manholes, are clogged. Street waste and littered garbage are often the items clogging sewer pipes. Currently, only about 70% of the solid waste is collected and disposed of. Overflowing of sewers, drains, and manholes is very frequent in rainy season.

The consumer survey of 1997 indicated that only about half of the NWSC water supply consumers have sewerage connections, on the other hand there are households that receive no water from NWSC which do have connections to sewers (Consumer Survey 1997, cited in Nippon Koei et al. 1999).

Wastewater treatment. Although several wastewater treatment plants have been constructed over the years in Kathmandu Valley, none, except for one at Gaurighat and another at Thimi, is fully functional. The Gaurighat treatment plant also faces technical difficulties (foaming in the aeration tank and sludge floatation in the secondary clarifier, besides high cost of operation). The untreated wastewater is discharged into the rivers.

Quality of municipal wastewater. Residential wastewater mainly contains discharge from the toilets (containing urine, faeces, soap, detergents, etc) and from the kitchen (containing foodstuff, fats, oils, etc). The composition of wastewater from residential sources can be expected not to vary much. However composition of wastewater generated by commercial activities varies according to the type of activity; for example, dry cleaning and photograph development use

Source: ENPHO

Kathmandu Guheshwori wastewater treatment plant

Source: ENPHO

Thimi wastewater treatment plant

Source: ENPHO

Kathmandu Dhobighat wastewater treatment plant

Source: ENPHO

Kathmandu Dhobighat wastewater treatment plant different chemicals generating wastewater of completely different compositions. However, wastewater from both residential and commercial sources is discharged into municipal sewers. Results of municipal wastewater quality tests on samples taken from sewers just before their discharge into rivers are summarised in Table 6.8.

Management of municipal wastewater. Many institutions are involved in dealing with wastewater in the urban areas of Kathmandu Valley (Figure 35).

The NWSC owns most of the sewer lines and treatment plants and is responsible for their operation and maintenance. However, as described elsewhere in this report, municipalities and other agencies also construct these facilities. The government has also formed a high-level committee for improving collection and treatment of wastewater in Kathmandu: the committee has constructed main sewers and a treatment plant upstream from Guheshwori.

Table 6.8: **Composition of municipal wastewater at selected locations**

Parameters (unit)	Location		
	Shantinagar, Naya Baneshwor	Jwagal, Patan	Dhalko Chhetra-pati
Total suspended solids (TSS, mg/l)	264.6	55.8	51.8
Total dissolved solids (TDS, mg/l)	446	504	321
EC (μS/cm)	891	1006	640
pH	7.2	7.3	7.2
Total alkalinity (mg/l as $CaCo_3$)	284	322	182
Dissolved oxygen (DO, mg/l)	0.21	0.36	0.27
BOD (mg/l)	164	57	62
COD (mg/l)	187	69	84
Sulphate (mg/l)	17	41	24
Chloride (mg/l)	89.7	74.6	50.8
Total phosphate (mg/l)	13.2	4.5	8.2
Total nitrogen (mg/l)	81.6	74.1	71.5
Ammonia-N (mg/l)	21.3	15.7	13.8
Nitrate-N (mg/l)	<0.01	0.02	<0.01
Nitrite-N (mg/l)	51.3	50.6	51.6
Lead (mg/l)	<0.05	<0.05	<0.05
Cadmium (mg/l)	<0.05	<0.05	<0.05
Chromium (mg/l)	<0.05	<0.05	<0.05
Mercury (mg/l)	<0.001	<0.001	<0.001
Phenol (mg/l)	0.03	0.03	0.02
Detergent/ soap (mg/l)	0.12	0.16	0.13
Total coliform (number / 100 ml)	TNTC	TNTC	TNTC
Faecal coliform (number / 100 ml)	TNTC	TNTC	TNTC

Source: ITECO Nepal (P) Ltd. 2002
Key: TNTC – Too numerous to count (>50,000 per 100 ml)

Although municipalities are constructing drains that feed into the sewers and have recently begun construction and operation of treatment plants, such as the one in Thimi, there is little coordination with NWSC which owns most of the sewerage works in Kathmandu. Lack of coordination is also apparent between the two ministries, the Ministry of Local Development (MoLD) and the Ministry of Physical Planning and Works (MoPPW) which are the line ministries respectively for municipalities and the NWSC. Although NWSC has been the key central agency for municipal wastewater management in the country, the LSGA gives municipalities the authority to manage wastewater.

Septic tanks and septage

Septic tanks are the most common method of managing domestic wastewater in those parts of municipal areas where there is no sewer line. Effluent from the septic tank is discharged either into a soak pit where the effluent percolates inside the ground or into a drain. The number of septic tanks in the municipalities of

Source: ENPHO

Teku sludge septage

Kathmandu, Lalitpur, and Bhaktapur is estimated to be 33,000, 8,400, and 2,300 respectively (Metcalf and Eddy 2000). Although various agencies, including the private sector and the municipalities, provide facilities for suctioning and cleaning them, septic tanks are not cleaned as frequently as required. The tanks, therefore, do not function efficiently; consequently septage has a higher pollution load than normally expected. When cleaned, the septage collected is generally dumped into the river or into a sewer/ drain which is connected to the river. There is no septage treatment facility (constructed wetland developed by KMC is not functional at present).

Industrial wastewater

Washing and dyeing (carpets and garments), dairies, paper and pulp board mills, textile mills, fat and oil presses, alcohol distilleries, and pharmaceutical industries in Kathmandu are identified as the main water-polluting industries in the valley. Kathmandu Valley hosts more than 72% of the country's water-polluting industries. Carpet washing and wool dyeing units discharge 6.1 Ml/day of wastewater, while other water-consuming industries discharge 2.4 Ml/day (MoPE 1999). These industries meet their water needs from the NWSC network or through their own groundwater supplies. The industrial wastewater is discharged without pre-treatment or neutralisation either to municipal sewers that flow into rivers or directly into rivers without pre-treatment or neutralisation.

Of the total wastewater (domestic and industrial) discharged into the rivers of the valley, the proportion from industrial effluents is about seven per cent (Devkota and Neupane 1994, cited in UNEP 2001). The pollution potential of industrial effluent, however, is higher than for other wastewater sources as it contains chemicals and toxic substances.

The contents of industrial wastewater vary widely depending on the type of industry and products. Municipal wastewater treatment plants are not designed to treat industrial effluents without pre-treatment or neutralisation.

Test results on mixed industrial effluents from Balaju and Patan industrial estates are given in Table 6.9.

Table 6.9: **Composition of effluents from Balaju and Patan industrial estates**

Parameters	Balaju	Patan
Total suspended solids (TSS, mg/l)	86	27.7
Total dissolved solids (TDS, mg/l)	324	550
EC (μS/cm)	646	1096
pH	7.7	7.3
Total alkalinity (mg/l as $CaCo_3$)	193	238
Dissolved oxygen (DO, mg/l)	4	0.57
BOD (mg/l)	113	92
COD (mg/l)	194	164
Sulphate (mg/l)	25	39
Chloride (mg/l)	55.6	150.8
Total phosphate (mg/l)	4.9	1.4
Total nitrogen (mg/l)	8.03	14.9
Ammonia-N (mg/l)	6.2	5.5
Nitrate-N (mg/l)	0.18	<0.01
Nitrite-N (mg/l)	1.09	7.6
Lead (mg/l)	0.08	0.11
Cadmium (mg/l)	<0.05	<0.05
Chromium (mg/l)	<0.05	<0.05
Mercury (mg/l)	<0.001	<0.001
Phenol (mg/l)	0.06	0.04
Detergent/ soap (mg/l)	0.1	<0.1
Total coliform (number / 100 ml)	TNTC	TNTC
Faecal coliform (number / 100 ml)	TNTC	TNTC

Key: TNTC = too numerous to count (>50,000 per 100 ml)
Source: ITECO Nepal (P) Ltd. 2002

Impact

The impacts of inadequate and improper management of waste are many: direct and indirect adverse impacts on health and well-being, pollution of water and air, impacts on cultural sites, impacts on aquatic life and the ecosystem, bad aesthetics, and others.

Health impact

Although disaggregated data are not available on health impacts of waste, it is well understood that there is a vital link between them. Water and air pollution definitely have impacts on people's health. Water and sanitation-related diseases are the most prevalent diseases in Nepal, including in the Kathmandu Valley: people who come into direct contact with waste are the most vulnerable, e.g., waste-management workers, waste-pickers, people living near waste facilities, users of polluted river water, and so on.

Air and water pollution

People quite commonly burn solid waste, including plastic, in the open air. This sends particulate pollutants as well as some toxic elements into the air that people inhale. Street sweeping also sends particulates into the air. As only around 75% of the solid waste generated in Kathmandu Valley's municipalities is collected, the remaining waste stays on the street and is a source of dust in the air. Solid waste dumped on the bank of the Bagmati and Bishnumati rivers is a long-term source of pollution for these rivers.

Wastewater from the urban areas of Kathamndu Valley ultimately flows into the Bagmati River and its tributaries: Manohara, Hanumante, Godavari, Kodku, Dhobhikhola, Tukucha, Bisnumati, Balkhu, and Nakhu. Studies indicate that most of the streams in the urban stretches of the valley are unsuitable for use as sources of water or for any other purpose.

The findings of a recent study on the water quality of these rivers/ streams post-monsoon are summarised in Table 6.10. The pre-monsoon tests also show a similar pattern, although values differ: pollution levels are generally higher during pre-monsoon, as there is less flow/ less dilution, and lower during monsoon due to higher flow/ dilution.

As expected, the study also showed that, in most of the rivers of Kathmandu Valley, the upper stretches before urban settlements begin are relatively clean: apart from bacterial contamination, most of the quality parameters were found to be within WHO guideline values for drinking water. The river becomes more and more polluted downstream as it flows through the urban area: during dry season the rivers are so polluted in the urban

Source: ENPHO

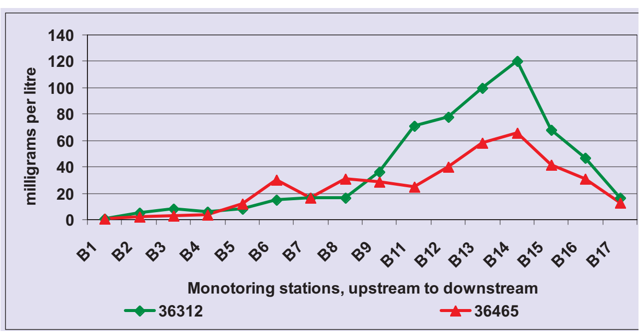
Dhobhikhola polluted

Table 6.10: **Summary of water quality in the Bagmati and its tributaries (post-monsoon test November 1999)**

River	Summary of findings
Bagmati River (Sundarijal to Khokana)	TSS increases from about 5 to 70 mg/l; chloride from 1.0 to 24 mg/l; Ammonia from 0.03 to 11 mg/l; BOD form 1.3 to 65 mg/l; and DO decreasing from 8.9 to 1.7 mg/l as the river flows through urban areas. The water quality suddenly deteriorates after joining the Dhobi Khola and becomes worse after joining the Tukucha and Bishnumati. After this, however, the water quality improves: at Khokana, DO value revives to 6.0 mg/l with corresponding decreases in BOD, NH_3, and other pollutant concentrations. Phenol concentration up to 0.07 mg/l in Jorpati and its immediate area (a number of carpet dyeing and washing facilities exist along the riverbanks in this area).
Hanumante River (Khasyang-khusung to Koteshwor)	The water quality first declines as it flows, but improves after other streams join (Manohara, Godavari). For instance, Cl^- increases from 9 to 12 mg/l and then decreases to 10 mg/l; similarly Ammonia from 0.19 to 4 mg/l and then to 2.8 mg/l; BOD from 5 to 12.07 mg/l and then to 7.3 mg, DO decreases from 7.5 to 2.1 mg/l and then increases to 7.8 mg/l. Phenol is detected at 0.002 mg/l.
Manohara River (Sarangchowk to Sankhamul)	Although it also becomes dirtier flowing downstream, the flow also increases from about $1m^3/s$ to $4m^3/s$. In comparison to other tributaries of the Bagmati River, the Manohara is much cleaner. For instance, DO values never go below 7.0 mg/l; BOD increases from 1 to 7.3 mg/l; COD from 1 to 21 mg/l, and ammonia from below 0.1 to 18 mg/l. The ammonia value jumped to 18 mg/l from about 0.2 mg/l just before joining the Bagmati.
Dhobi Khola	Upstream from the Kapan area (Lasuntar), water quality is fairly good except for bacteria contamination. Although suspended solids and iron content are fairly high, other parameters are within the drinking water limits. But as the stream flows downstream, it gets rapidly polluted with BOD load increasing from 78 kg/day to 2,132 kg/day and then to 11,919 kg/day (the highest BOD load of all tributaries except the Bishnumati). The causes may be attributed to proliferation of industrial activities, particularly carpet dyeing and washing and rapid urbanisation in the area. Pb, Cd, Cr, Al and Hg are not detected. Phenol concentration is found in one sample of around 0.07mg/l.
Bishnumati River (Tokha to Teku)	Water quality degrades gradually as it flows downstream and flow rate increases from 0.1 m^3/s to 2.6 m^3/s. Cl^- increases from about 2 to 26 mg/l, ammonia from 0.1 to 11 mg/l, BOD from 5 to 85 mg/l and DO decreases from about 7 to 1 mg/l. BOD load increases from 26 kg/day to 18,654 kg/day just before mixing with the Bagmati. The Bishnumati River carries the highest BOD load of all Bagmati tributaries. At the uppermost point near Tokha, the river quality seems to be much better than at downstream points. Cd, Cr, Al and Hg are not detected. But Phenol concentration (0.05 mg/l) and Pb (0.015 mg/l (in one sample) were found.
Nakhu,Godavari, Tukucha, and Balkhu rivers	The water quality of the Nakhu and Godavari kholas are in very good condition except for bacterial contamination. Tukucha is almost sewage with DO near zero and BOD 260 mg/l. Balkhu Khola upstream is good whereas the downstream stretch is a little more contaminated, with BOD increasing from 3 to about 12 mg/l.

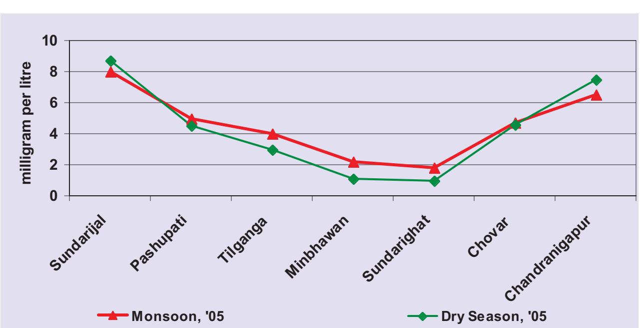
Source: MWSP- Project Management Consultant 1999 sections that they resemble open sewers. Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Ammonia exceed the accepted quality standards for river water. Dissolved Oxygen (DO) levels during dry season in most of the river stretches near settlements within Kathmandu Valley are nearly zero. Domestic/ municipal sewage appears to be the main contributor to pollution as heavy metal and toxic substances, e.g., toxic metals, such as Lead (Pb), Cadmium (Cd), Chromium (Cr), and Mercury (Hg), have not been detected in most samples tested. Phenol is found more frequently. During low-flow periods, the water conditions are septic and are an unfavourable habitat for any kind of freshwater aquatic life (Nippon Koei et al. 1999)

The quality of river water near urban settlements is so poor that it resembles sewage. The BOD_5 counts of water from the Bagmati at Tinkune and Kamochan were 108 mg/l and 140 mg/l respectively. Figures 36 and 37 show the variations of BOD5 and DO respectively along the length of the Bagmati River as it flows through urban areas (NESS 2006). The DO starts to rise and BOD_5 decrease after Chobhar. The quality of water samples from the Bishnumati, Dhobikhola, and Tukucha are no different from this or are even worse.



Source: NESS 2006

Figure 36: BOD_5 seasonal variations in the Bagmati River



Source: NESS 2006

Figure 37: Change in DO levels in the Bagmati River in both dry and monsoon seasons

Uses of river water

Villagers immediately downstream from Kathmandu have stopped using water from the river for irrigation, and fishermen have ceased their traditional occupation, as there are no fish left in the river (ADB/ ICIMOD 2006).

Aesthetic and cultural practices

An extremely polluted, sewage-filled, black stream flowing through the heart of a city obviously destroys its beauty. There are several points on the Bagmati and Bishnumati rivers that are considered holy: people perform rituals and bathe at these points. Pollution has affected cultural and religious activities and rituals – ritual bathing is almost a thing of the past, and people do not use water from the river even when performing ‘puja’ (worship) (NESS 2006; ADB/ICIMOD 2006). Bad aesthetics may also adversely affect tourism.

Water ecology

The Bagmati, Bishnumati, Dhobikhola, Tukucha, Manohara, and Hanumante rivers in Kathmandu Valley’s urban areas or close to it no longer have any freshwater aquatic life: the river is almost dead, and aquatic life almost non-existent by the time the river reaches Chobhar (NESS 2006; ADB/ICIMOD 2006)

Response

Policy, legislation, and standards

Sustainable Development Agenda for Nepal (SDAN) 2003. The SDAN is wide-ranging and incorporates several goals related to the environment. Its objectives for solid waste management include promoting waste reduction as well as increased re-use and recycling. It states that the government will encourage research and industry to work together to create cyclical flows of material, requiring factory products to be easily disassembled and separated by material type, and factory by-products to be reused. The agenda also includes a commitment to creating conditions that facilitate establishment of recycling centres that have economy of scale and establishment of hazardous waste management centres whose costs are met by the product causing the waste. Only non-recyclable waste is to be disposed of in environmentally-sound sanitary landfills.

Tenth Five-year Plan (2002-2007). The 10th plan identifies solid-waste management as a priority environmental issue / concern in the urban areas of Nepal. The final disposal sites for solid waste are recognised as the main difficulty; hence, importance is given to developing land-fill infrastructure, particularly for the Kathmandu Valley (at Banchare Danda and Okharpauwa). The 10th Plan also proposes the monitoring of air, solid waste, and water quality to reduce hazards to human health.

National Solid Waste Management Policy 1996. The aim of the policy is to make the solid-waste management system simple and effective; minimise its adverse impacts on the environment and public health; mobilise it as a resource; privatise its management; and raise public awareness on the importance of managing it. The policy gives various promotional activities to meet the above aims: awareness campaigns, development of technology/ expertise at local level, and tax rebates for products that use solid waste. The policy envisions institutional arrangements at two levels: national level to develop the capabilities and skills needed and local level for management in respective areas. Local institutions are to follow standards and concepts approved by the government and are to be responsible for mobilising human and other resources at local level, involving NGOs, collecting service charges, and fines for offenders.

Although there is room for improvement, the policy is a good initiative; although implementation has been weak. There was no budget or plan of implementation.

Industrial Development Perspective Plan. The perspective plan offers an economic analysis of the manufacturing industry, long-term vision (2020), and the challenges expected to emerge. The plan recognises the need to prevent pollution and gradually improve the performance of industries in the global as well as national context in this respect. It suggests a two-pronged approach to improve environmental performance on the part of industry: first through cleaner production in existing industries and second through effective compliance with IEEs and EIAs in newly-proposed industries. It also recommends introduction of tradable pollution permits.

Solid Waste Management and Resource Mobilisation Act/ Rules. Promulgated in 1987, these acts and rules were the first laws in Nepal related to solid waste management. The act provided a basis for managing solid waste in Kathmandu's urban areas; and established SWMRMC as an autonomous body to deal with solid waste, particularly in Kathmandu, Lalitpur, and Bhaktapur municipalities. After enactment of the LSGA in 1999, most solid-waste management functions were handed over to municipalities and the Centre was placed under the MoLD to focus on policy issues.

Nepal Water Supply Cooperation (NWSC) Act/ Rules. This act appoints the Nepal Water Supply Cooperation as the body responsible for water supplies in urban areas of Nepal. It also makes it responsible for sewerage management and wastewater treatment plants in the municipalities. The act is currently being revised to promote private-sector participation and bring it into line with with the LSGA 1999.

Industrial Enterprises Act/Rules. This act categorises industries in relation to their impact on public health and the environment. It empowers the government to issue directives to industries to prevent and mitigate environmental pollution. The act also provides tax relief on investments in pollution control.

National Water Supply Sector Policy 1998. This policy aims to integrate water supply and sanitation as well as to reduce the incidence of water-related diseases.

Waste Water Management Policy (draft 2006). The draft policy is probably the first national-level response to the environmental and public health impacts of wastewater. It recognises the need to improve compliance with standards, to improve coordination among various stakeholder agencies, and to foster public-private partnership; proposes separate sewerage for storm and sanitary sewage; and aims to improve quality of water bodies.

Water Resources' Strategy, National Water Plan, 2005 advocates additional water supply and sanitation coverage and improving the level of services

Environment Protection Act 1996/ Rules 1997. This Act makes pollution a punishable offence and empowers the government to provide additional incentives (concessions and facilities) to encourage any enterprise, activity, technology, or process that will have positive environmental impacts. The EPA/ EPR also provide a framework for environmental assessment such as Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA). All activities proposed are subject to environmental screening on the basis of type, size, and location. The SWMRMC has developed EIA Guidelines for a Solid Waste

Management Project in the Municipalities of Nepal (2004) to help implement the environmental assessment provisions of the EPA/EPR.

Local Self Governance Act/Rules 1999. This Act makes the municipalities responsible for solid-waste management in their respective territories. The LSGA authorises levées for fines and recurring expenses to dispose of waste and issuing of orders to maintain cleanliness and safe disposal of waste and maintain sanitary conditions in public places.

There are contradictions/overlaps/ duplications of authority in the Solid Waste Management and Resource Mobilisation Act 1987, Solid Waste Management National Policy 1996, and LSGA 1999. Streamlining these policy and regulatory provisions is essential to determine where the authority and responsiblity of institutions involved in solid-waste management lie. A review is currently being undertaken at the MoLD in this respect.

Standards. The government has issued three generic effluent standards (tolerance limits) for discharge of industrial waste into inland surface water, wastewater from combined treatment plants into inland surface water, and industrial effluent into public sewers, as well as one sampling standard and one testing standard. Besides, there are nine industry-specific effluent standards (tolerance limits) for discharge into inland surface water: the industries included are tanning, wool processing, fermentation, vegetable ghee and oil production, paper and pulp mills, dairy products, sugar mills, cotton textile mills, and soap manufacturing. However, these are neither monitored nor enforced.

Plans, programmes and projects

CKV – Clean Kathmandu Valley Study. The Study of Solid Waste Management for the Kathmandu Valley, popularly known as th Clean Kathmandu Valley (CKV) Study is the most recent and comprehensive study on solid waste management in the five municipalities of the Kathmandu Valley. The study proposes an umbrella concept for solid waste management facilities with short-term, mid-term, and long-term plans by grouping municipalities into two zones. The study lasted 20 months (from January 2004 to August 2006) during which time a series of pilot projects were designed and implemented for improving collection and transportation, minimisation of waste, improving disposal, promoting awareness and behavioural change, and developing operation and management capacity.

High Powered Committee for Implementation and Monitoring of the Bagmati Area Sewerage Construction/Rehabilitation Project. The government formed this High Powered Committee to examine ways of improving the quality of water in the Bagmati River through priority sewer lines and treatment plants. A master plan was prepared in the late 90s envisioning roads and a green belt on either side of the Bagmati from Sundarijal to Chobhar; repair of the existing sewers and treatment plants; and establishment of additional treatment plants, e.g., at Gokarna, Guheshwori, Dhobi Khola confluence; Sanepa, Manohara, Bishnumati confluence; Dhobighat; and at Nakhkhu. The master plan suggested parallel development of sanitary sewers and storm water drains with interceptor lines. The High Powered Committee established a treatment plant at Gaurighat, the main sewer line upstream from it, and a tunnel for a sewer from Gaurighat to Tilganga that conveys sewage downstream from the Pashupatinath area, bypassing religious and ritual sites.

Melamchi Water Supply Project. The Melamchi Water Supply Project plans to divert water from the Melamchi River to Kathmandu Valley through a 26 km long tunnel. The idea is to improve water supplies through water treatment plants, bulk supply lines, and improvements in the distribution network and wastewater disposal system. The total cost is estimated at US $ 500 million and its target is to bring 170 million litres of water per day to the capital. It is hoped that this will increase water supplies to the Kathmandu Valley in the medium-to-long run. The ADB is the lead donor with contributions from the government and other donors such as the World Bank, the Japanese Bank for International Cooperation, Nordic Development Fund, Swedish International Development Agency, and Norwegian Aid Agency.

Past Plans and Projects. Several plans and projects have been prepared and implemented in the past to improve solid waste and wastewater management in urban areas of the Kathmandu Valley: the GTZ supported solid-waste management project for Greater Kathmandu and Bhaktapur Development Project; and wastewater related projects such as the Master Plan for Water Supply and Sewerage in Greater Kathmandu and Bhaktapur, Second Water Supply and Sewerage Project, Greater Kathmandu Drainage Master Plan Studies, Kathmandu Valley Urban Development Plan and Programmes, Bagmati Basin Water Management Strategy and Investment Programme, Urban Water Supply and Sewerage Rehabilitation Project, and Environmental

Sector Programme Support.These projects all contributed to establishing the facilities extant.

The results of these efforts are given below.

- Introduction of modern solid-waste management practices (e.g., construction and operation of the Teku Transfer Station, Gokarna Landfill Site (closed now), and now construction and operation of the Sisdol Landfill Site.
- Construction of sewers (Table 6.11) and wastewater treatment plants (Table 6.12).
- Construction of Wastewater Treatment Plants. There are seven wastewater treatment plants (WWTPs) in five-municipalities in the Kathmandu Valley (Table 6.12). At present, most of these treatment plants are either not in operation, or in a poor state of maintenance. Most of the centrally collected wastewater treatment plants are not functioning due to high cost of spare parts, chemical additives, utility bills, and lack of trained human resources.
- Emerging initiatives. These include initiatives by the private sector and NGOs in solid waste management activities such as door-to-door collection, community composting and recycling, promotion of household composting by the municipalities, constructed wetland to treat wastewater, and promotion of cleaner production by industries, etc.

Table 6.11: **Length of sewers in five municipalities of Kathmandu (km)**

Municipality	Sewer length (km)	Remarks
Kathmandu	3,246	Includes major and minor sewers as well as 'nali' (s). Kathmandu's data probably cover Lalitpur as well. It's unsure whether t hese data include sewers and drains built by all agencies.
Lalitpur	N.A.	
Bhaktapur	30	
Madhyapur Thimi	26	
Kirtipur	19	

Source: Relevant municipalities cited in CBS 2005

Table 6.12: **Wastewater treatment plants in Kathmandu Valley**

Plant	Capacity (mld) and type	Status
Dhobighat: receives wastewater from the main urban area of KMC. Constructed in 1978 with IDA funding.	15.4 mld. Oxidation Pond consisting of two primary anaerobic ponds, one secondary facultative pond, and a tertiary aerobic pond. Wastewater requires pumping from Sundarighat pump station.	Not operational, out of operation almost since construction. Problem began with pumping wastewater and conveying through under-river sewer.
Kodku: receives wastewater by gravity from the eastern core areas of Lalitpur. Constructed in 1978 with IDA funding.	1.1 mld. Oxidation pond: consists of two primary/ anaerobic ponds, one secondary/ facultative pond, and one tertiary/ maturation pond.	Partially operational but inefficient. Poor O & M: sludge accumulation and non-functioning flow-control valve, resulting flow short-circuiting (less detention time). Farmers tap raw sewage flowing through sewers for irrigation.
Sallaghari: receives wastewater from some parts of Bhaktapur urban area. Constructed in 1983 with GTZ support.	2.0 mld. Originally designed as an aerated lagoon system using diffused aeration equipment. The plant is now converted to a non-aerated lagoon.	Partially operational. Difficulties related to pumping and operation of mechanical aerators. Farmers tap raw sewage flowing through the sewers for irrigation.
Hanumanghat: serves only a small part of the core area of Bhaktapur. Constructed in 1977 with GTZ support.	0.5 mld. Originally developed as an aerated lagoon.	Partially operating as an oxidation pond/ non-aerated lagoon with low efficiency.
Guheshwori: constructed by the High Power Committee in 1999.	17.3 mld. Activated sludge oxidation ditch.	In operation. High operating costs: in 2005, it was over NRs 10 million (about 65 % of this was for electricity). Foaming in aeration tank is the major technical difficulty. there is also a sludge rise/ flotation problem in the secondary clarifier (Sah 2006).
Teku: constructed by Kathmandu Municipal Cooperation.	Constructed wetland – vertical flow bed	For treating septage (from septic tanks). Not in operation
Madyapur Thimi: constructed with technical support from ENPHO as a pilot demonstration activity of ADB, UN-Habitat, and Water Aid Nepal	Reed Bed Treatment System – horizontal/ vertical flow bed	Serves around 200 households, and receives about 30 m^3/ day of sewage. This has recently come into operation. The municipality looks after the O& M.

Key: mld = million litres per day

Source: Timilsina 2004; Nippon Koei et al. 1999; Metcalf and Eddy 2000; ENPHO leaflet


"राष्ट्रिय भूकम्प सुरक्षा दिवस"
२ माघ,२०६०
भूकम्पबाट सुरक्षित हुन प्राविधिकहरूको
सल्लाह लिई सुरक्षित घर बनाऔं।