Pilot Project C-7

Environmental Monitoring
at Sisdol Landfill Site

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1 Introduction

Sisdol short-term landfill site (S/T-LFS) is a semi-aerobic landfill site that has been constructed recently at Sisdol in Nuwakot. This landfill site started operating on June 5, 2005 (World Environment Day). Currently, small portion of total solid waste of Kathmandu and Lalitpur is being managed at the landfill site. According to KMC, the landfill site will receive much more amount of waste from Kathmandu and Lalitpur once it is equipped with required number of secondary transportation vehicles and other facility in the near future.

The JICA Study Team engaged Environment and Public Health Organization (ENPHO) as a qualified non-governmental organization to conduct ground water, surface water and leachate monitoring at Sisdol S/T-LFS as part of the Pilot Project C.

2. Objective

The specific objectives of this environmental monitoring were:

- To measure and analyze ground water, surface water and leachate parameters mentioned in the scope of works and specification provided
- To support the Environmental Monitoring Committee for Sisdol S/T-LFS

3. Methodology

3.1 Field Work

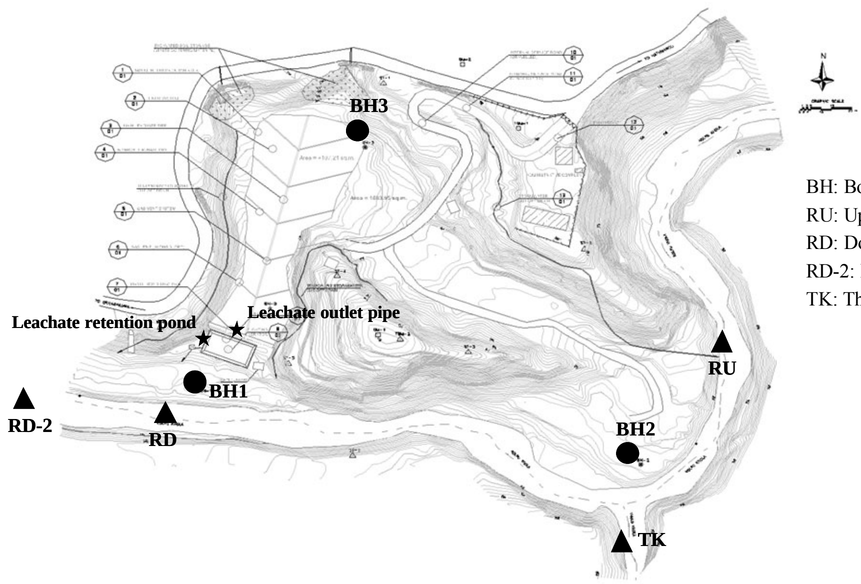
Following field activities were carried out for the environmental monitoring:

Locating Sampling Points

Monitoring activities were carried out at the following locations:

- Ground water monitoring in three bore holes (Bore hole 1, bore hole 2 and bore hole 3)
- Surface water monitoring at 3 locations along Kolpu river (1 point at upstream and 2 points at down stream), and 1 point at Thulo khola (10 meters upstream from confluence of Kolpu and Thulo khola). Besides, water quality of a small ditch that was running over the landfill site before construction was also monitored.
- Leachate monitoring at 2 points (leachate coming out of the outlet pipe from LFS and leachate in the pond)

All locations are shown in the map below.



Sampling Location of Environmental Monitoring

Equipment Used on the Site

The parameters that were measured at all sampling locations at Sisdol S/T-LFS, equipment that was used and methods that were followed are shown in the table below.

Field Measurements		
Parameter	**Method**	**Equipment**
Climate	Metrology Department of HMG	-
Air temperature	-	Thermometer
Water temperature	-	Thermometer
Color	Visual	-
Turbidity	Visual	Turbidity Tube
Odor	Smell	-
River velocity	Distance/time method	Field measuring tape
River Cross section Area	Measurement of width and depth of water	Field measuring tape
River discharge volume	Discharge volume = Velocity of river cross section area of river	-
Groundwater level	Piezometric	Piezometer
Photograph	-	Digital Camera

Sampling

Samples were collected from each sampling site for laboratory analysis. Samples were collected in washed, rinsed and/or sterile bottles, preserved by adding necessary chemicals, packed in ice cooled boxes and brought to laboratory same day.

3.2 Laboratory Analysis

Parameters that were measured in the laboratory, equipment that was used and methods that were followed are shown in the table below.

Parameter	Method	Equipment
pH	Potentiometric	pH meter
DO	Titration (Alkali-Iodide Azide modification)	-
EC	Potentiometric	Conductometer
TDS	Gravimetric	-
TSS	Gravimetric (filtration and weighing of residue)	Scaletec, SBA 32, Max. 120 kg, d = 0.0001g
HCO3-	Titrimetric	-
BOD	5 days incubation at 20oC and titration of initial and final dissolved oxygen	Incubator Kottermann, 2771
COD	Dichromate Oxidation & Titration with ferrous ammonium sulphate	COD digestion unit
Oxidizability with KMNO4 as O	Titrimetric	-
Chloride	Argentometric titration	-
Calcium	EDTA Titration	-
Sodium	Emission (Flame Photometric)	-
Sulfate ion SO4-	Gravimetric (Precipitation with BaCl2 Solution)	-
Sulfite SO3-	Iodometric	-
Sulfide (S)	Iodometric	-
Ammonia	Spectrophotometric (Phenate method)	Perkin Emler, Lamda EZ 150, USA
Nitrite (NO2-N)	Spectrophotometric (NED-Dehydrate Chloride+Sulphanilamide)	-
Nitrate (NO3-N)	UV Spectrometric Screening	-
Total-N	Kjeldahl –N+NO3-N+NO2-N	Kjeldahl digestion apparatus
Phosphate (PO4-P)	Ammonium Molybdate ascorbic acid reduction method	-
Oil and grease	Extraction (gravimetric)	-
Coliform group number	Membrane filter Technique	Millipore
Phenol compounds	Spectrophotometric (Aminoantipyrine)	-
Fluoride (F)	Spectrophotometric	-
Arsenic (As)	Atomic Absorption Spectrometer (AAS), Hydride generation	-
Cadmium	Atomic Absorption Spectrometer (AAS)	-
Total Chromium	Atomic Absorption Spectrometer (AAS)	-
Hexavalent chromium (Cr)	Spectrophotometric (Diphenyl Carbozide)	-
Copper (Cu)	Atomic Absorption Spectrometer (AAS)	-
Lead (Pb)	Atomic Absorption Spectrometer (AAS)	-
Mercury (Hg)	Atomic Absorption Spectrometer (AAS),Cold vapour)	-
Nickel (Ni)	Atomic Absorption Spectrometer (AAS)	-
Selenium (Se)	Atomic Absorption Spectrometer (AAS)	-
Zinc (Zn)	Atomic Absorption Spectrometer (AAS)	-
Iron (Fe)	Atomic Absorption Spectrometer (AAS)	-
Manganese (Mn)	Atomic Absorption Spectrometer (AAS)	-

4. Time Schedule

Activities	2004		2005					
	July	**August**	**March**	**April**	**May**	**June**	**July**	**August**
Field measurements and sampling Phase I	■	■						
Laboratory Analysis Phase I	■	■						
Field measurements and sampling Phase II			■				■	■
Laboratory Analysis Phase II			■	■	■	■	■	■
Field measurements and sampling Phase III								■
Laboratory Analysis Phase III								■

5. Results and Discussion

Ground Water Quality - Before Operation –

Parameter	Unit	July 27, 2004[*1] or August 12, 2004[*2]			March 01, 2005			March 20, 2005			May 24, 2005 (Additional)[*3]		
		BH1[*1]	BH2[*2]	BH3[*3]	BH1	BH2	BH3	BH1	BH2	BH3	BH1	BH2	BH3
Weather	_	Partially cloudy	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny; rain previous day	Sunny; rain previous day	Sunny; rain previous day	Sunny	Sunny	Sunny
Air temperaure	°C	29	31	31	23	22	22	23	24	23	33	33	32
Water temperature	°C	23	24	24	21	20	19	22	23	21	22	23	24
Groudwater level (from surface)	m	1.4	1.8	0.15	2.4	3.5	1.4	2.1	3.5	1.2	2.1	3.5	1.6
Color/appearance	_	light grey	grey	light grey	Colorless	Grey, muddy	Light grey	Colorless	Grey	Colorless	Colorless	Faint grey	Colorless
Turbidity	NTU	300	2000	300	30	500	40	50	200	30	10	100	10
Odor	_	light muddy	muddy	light muddy	Odorless	Soily	Odorless	Odorless	Soily	Odorless	Odorless	Odorless	Odorless
pH	_	7.3	7.4	6.8	7.6	6.7	6.3	7.5	6.5	6.3	6.3	6.5	6.2
Electrical Conductivity (EC)	uS/cm	136	243	96	208	178	157	230	145	145	22	150	150
Dissolve Oxygen (DO)	mg/L	4.9	6.5	7.0	4.5	1.8	5.0	4.0	4.1	4.8	5.2	3.4	4.5
Total Dissolved Solids (TDS)	mg/L	-	-	-	152	158	139	166	102	75	147	120	139
Total Suspended Solids (TSS)	mg/L	465	1936	230	334	27524	396	213	9079	560	76	484	152
Hydrogen Carbonate (HCO3-)	mg/L	-	-	-	104	58	52	106	68	50	80	58	44
Biological Oxygen Demand (BOD)	mg/L	25.0	30.0	20.0	17.5	420.0	20.0	12.5	80.0	15.5	3.0	17.0	3.4
Chemical Oxygen Demand (COD)	mg/L	119.9	127.7	43.3	44.5	980.0	44.0	43.0	250.0	32.5	18.0	34.0	21.5
Oxidizability with KMnO4 as O	mg/L	-	-	-	20.2	627.8	19.8	27.4	235.8	33.4	4.0	24.8	6.7
Chloride ion (Cl-)	mg/L	2	19	9	3	11	9	4	5	9	5	5	9
Calcium (Ca++)	mg/L	-	-	-	28	28	12	40	22	12	25	20	10
Sodium (Na+)	mg/L	-	-	-	9.9	45.9	14.6	20.9	11.5	15.8	11.4	7.5	14.5
Sulfate (SO4-)	mg/L	-	-	-	<1	3.5	<1	1.0	1.0	0.8	<1	<1	<1
Sulfite (SO3-)	mg/L	-	-	-	1	2.5	1	<0.5	1.5	<0.5	-	-	-
Sulfide (as S)	mg/L	-	-	-	<0.4	0.80	<0.4	<0.4	<0.4	<0.4	1.60	2.00	1.2
Phenol compounds	mg/L	-	-	-	0.02	0.09	0.14	-	-	-	-	-	-
Fluoride (as F)	mg/L	-	-	-	0.47	0.07	0.36	-	-	-	-	-	-
Arsenic (as As)	mg/L	-	-	-	ND (<0.005)	0.072	0.007	-	-	-	-	-	-
Cadmium (as Cd)	mg/L	-	-	-	ND (<0.001)	ND (<0.001)	ND (<0.001)	-	-	-	-	-	-
Total Chromium (as Cr)	mg/L	-	-	-	0.06	0.66	ND (<0.02)	-	-	-	-	-	-
Hexavalent chromium (as Cr)	mg/L	-	-	-	0.02	0.34	ND (<0.02)	-	-	-	-	-	-
Copper (as Cu)	mg/L	-	-	-	0.019	0.463	0.01	-	-	-	-	-	-
Lead (as Pb)	mg/L	-	-	-	2.125	10.890	0.545	-	-	-	-	-	-
Mercury (as Hg)	mg/L	-	-	-	0.13	0.02	ND (<0.01)	-	-	-	-	-	-
Nickel (Ni)	mg/L	-	-	-	0.026	0.492	0.008	-	-	-	-	-	-
Selenium (Se)	mg/L	-	-	-	ND (<0.005)	ND (<0.005)	ND (<0.005)	-	-	-	-	-	-
Zinc (as Zn)	mg/L	-	-	-	0.071	3.984	0.039	-	-	-	-	-	-
Iron (as Fe)	mg/L	-	-	-	22.65	486.37	17.25	-	-	-	-	-	-
Manganese (as Mn)	mg/L	-	-	-	0.273	4.5	0.457	-	-	-	-	-	-
Ammonia Nitrogen (NH4-N)	mg/L	0.6	18.0	2.1	1.1	0.7	1.1	2.3	3.5	1.0	5.3	0.5	0.4
Nitrate Nitrogen (NO3-N)	mg/L	-	-	-	1.0	1.5	1.5	ND (<0.05)	1.6	0.6	ND (<0.05)	4.0	3.3
Nitrite Nitrogen (NO2-N)	mg/L	-	-	-	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Total Nitrogen (T-N)	mg/L	4.6	24.3	8.0	6.1	18.0	8.6	5.9	20.3	7.0	8.3	8.4	6.9
Phosphorous Phosphate (PO4-P)	mg/L	-	-	-	0.05	0.59	0.17	0.07	0.15	0.12	0.07	0.04	0.08
Total Phosphorous	mg/L	0.8	3.3	3.5	-	-		-	-	-	-	-	-
Oil and Grease	mg/L	27.8	14.0	14.6	2.6	0.4	7.2	2.2	1.8	5.0	0.6	0.8	0.4
Fecal Coliform	CFU/100 ml	15900	18200	10400	56	456	76	40	59	12	1298	1010	292

Note: ND: Non Detectable

*1, *2: Sampling of BH1 was carried out on July 27, 2004, and sampling of BH2 & 3 were on August 12,2004.

*3: Since BH2 seemed dameged by local people at the beginning of monitoring, the hole was rehabilitated in April, 2005, and additional sampling was conduted for confirming rehabilitation.

Samples were measured and analyzed by ENPHO

Ground Water Quality - After Operation –

Parameter	Unit	June 09, 2005			June 28, 2005			July 21, 2005		
		BH1	BH2	BH3	BH1	BH2	BH3	BH1	BH2	BH3
Weather	_	Sunny	Sunny	Sunny	Partially cloudy	Partially cloudy	Partially cloudy	Cloudy	Cloudy	Cloudy
Air temperaure	°C	30	31	31	29	29	30	28	28	27
Water temperature	°C	25	24	25	23	24	26	23	24	23
Groudwater level (from surface)	m	2.4	3.6	1.7	2.1	3.5	1.2	2	3.4	0.15
Color/appearance	_	Colorless	Light grey	Colorless	Colorless	faint grey	Colorless	Colorless	Colorless	Colorless
Turbidity	NTU	20	50	30	5	50	5	<5	5	5
Odor	_	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Sewage smell	Odorless	Odorless
pH	_	6.3	6.3	6.2	6.7	6.4	6.2	7.0	6.3	6.0
Electrical Conductivity (EC)	uS/cm	205	150	140	285	180	150	290	180	145
Dissolve Oxygen (DO)	mg/L	3.6	4.6	2.5	3.7	6.8	4.7	2.3	5.6	4.2
Total Dissolved Solids (TDS)	mg/L	184	107	105	202	149	115	164	84	102
Total Suspended Solids (TSS)	mg/L	36	145	222	4	87	10	164	40	168
Hydrogen Carbonate (HCO3-)	mg/L	90	56	48	112	30	52	124	28	54
Biological Oxygen Demand (BOD)	mg/L	10.0	9.4	10.6	7.0	11.0	9.0	25.0	27.0	15.5
Chemical Oxygen Demand (COD)	mg/L	12.5	20.5	19.5	20.0	40.0	27.0	70.0	41.0	40.0
Oxidizability with KMnO4 as O	mg/L	9.6	10.1	10.4	11.5	22.4	22.1	40.0	38.4	36.0
Chloride ion (Cl-)	mg/L	6	4	20	6	5	8	3	3	6
Calcium (Ca++)	mg/L	25.7	17.6	8.0	36.0	23.0	14.0	34.5	25.7	12.0
Sodium (Na+)	mg/L	12.3	8.2	15.0	14.4	8.6	12.9	23.7	11.6	21.0
Sulfate (SO4-)	mg/L	3.3	3.9	3.7	2.1	2.3	1.0	1.2	<1	<1
Sulfite (SO3-)	mg/L	2.0	1.5	0.5	7.5	6.0	8.5	15.0	25.0	25.0
Sulfide (as S)	mg/L	1.2	2.0	2.0	2.0	<0.4	<0.4	2.0	ND (<0.4)	ND (<0.4)
Phenol compounds	mg/L	-	-	-	0.17	0.04	0.01	0.04	0.01	0.01
Fluoride (as F)	mg/L	-	-	-	ND (<0.05)	ND (<0.05)	0.14	0.92	0.73	0.36
Arsenic (as As)	mg/L	-	-	-	ND (<0.005)	ND (<0.005)	ND (<0.005)	0.006	ND (<0.005)	ND (<0.005)
Cadmium (as Cd)	mg/L	-	-	-	0.003	0.001	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)
Total Chromium (as Cr)	mg/L	-	-	-	ND (<0.02)	0.024	ND (<0.02)	0.039	0.042	0.036
Hexavalent chromium (as Cr)	mg/L	-	-	-	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)
Copper (as Cu)	mg/L	-	-	-	ND (<0.02)	0.041	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)
Lead (as Pb)	mg/L	-	-	-	0.46	0.68	0.39	0.78	0.47	0.50
Mercury (as Hg)	mg/L	-	-	-	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.005)	ND (<0.005)	ND (<0.005)
Nickel (Ni)	mg/L	-	-	-	ND (<0.01)	0.019	ND (<0.01)	ND (<0.01)	0.011	ND (<0.01)
Selenium (Se)	mg/L	-	-	-	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)
Zinc (as Zn)	mg/L	-	-	-	0.023	0.086	0.041	0.05	0.12	0.05
Iron (as Fe)	mg/L	-	-	-	2.81	16.25	3.76	5.97	1.25	2.06
Manganese (as Mn)	mg/L	-	-	-	0.17	0.23	0.21	0.25	0.08	0.11
Ammonia Nitrogen (NH4-N)	mg/L	0.4	0.5	1.2	1.2	0.8	1.2	0.4	0.6	0.1
Nitrate Nitrogen (NO3-N)	mg/L	ND (<0.05)	2.5	3.0	ND (<0.05)	9.5	1.0	0.3	20.1	1.3
Nitrite Nitrogen (NO2-N)	mg/L	0.0	0.1	0.1	0.7	0.2	0.0	0.1	0.1	0.0
Total Nitrogen (T-N)	mg/L	3.5	9.0	7.7	3.8	12.1	6.1	3.1	23.3	5.4
Phosphorous Phosphate (PO4-P)	mg/L	0.49	0.04	0.17	0.13	0.04	0.08	0.09	0.03	0.05
Oil and Grease	mg/L	17.40	13.40	7.00	1.00	1.40	1.80	ND (<0.10)	ND (<0.10)	0.40
Fecal Coliform	CFU/100 ml	-	-	-	3000	10200	21900	510	168	364

Note: ND: Non Detectable

Samples were measured and analyzed by ENPHO

River Water Quality - Before Operation –

Parameter	Unit	July 27, 2004		March 01, 2005				March 20, 2005			
		RU	RD	RU	TK	RD	RD-2	RU	TK	RD	RD-2
Weather	_	Partially cloudy	Partially cloudy	Sunny	Sunny	Sunny	Sunny	Sunny; rain previous day	Sunny; rain previous day	Sunny; rain previous day	Sunny; rain previous day
Air temperaure	°C	29	29	23	24	24	24	24	24	23	23
Water temperature	°C	23	23	17	18	18	17	20	20	19	19
Discharge	m^3/sec	5.2	8.2	0.7	0.5	1.1	1.2	0.7	0.7	1.5	1.4
Color/appearance	_	Brown	Brown	Light grey	Light grey	Light grey	Light grey	Light grey	Light grey	Light grey	Light grey
Turbidity	NTU	500	500	50	25	75	100	40	40	40	50
Odor	_	Soily	Soily	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
pH	_	7.6	7.4	7.9	8.2	8.3	8.4	7.8	8.1	7.8	7.8
Electrical Conductivity (EC)	uS/cm	33	51	80	175	122	127	66	155	98	98
Dissolve Oxygen (DO)	mg/L	7.3	7.1	9.5	8.4	9.1	9.0	7.8	8.2	8.4	8.5
Total Dissolved Solids (TDS)	mg/L	-	-	53	140	93	102	43	107	87	84
Total Suspended Solids (TSS)	mg/L	350	295	186	140	266	356	110	74	85	107
Hydrogen Carbonate (HCO_3^-)	mg/L	28	-	28	20	32	36	26	30	38	30
Biological Oxygen Demand (BOD)	mg/L	15.0	17.0	4.0	0.4	7.2	7.0	1.1	0.9	1.0	1.2
Chemical Oxygen Demand (COD)	mg/L	24.0	21.8	25.0	14.0	19.5	22.0	22.5	17.5	20.0	22.5
Oxidizability with $KMnO_4$ as O	mg/L	-	-	10.4	9.3	11.0	15.8	16.9	12.6	13.2	13.0
Chloride ion (Cl^-)	mg/L	1	<1	3	3	4	3	5	7	7	9
Calcium (Ca++)	mg/L	-	-	9.6	24.0	16.0	16.0	13.0	20.0	12.0	15.0
Sodium (Na+)	mg/L	-	-	8.7	8.5	8.7	9.3	8.3	9.7	9.1	8.9
Sulfate ($SO4^-$)	mg/L	-	-	<1	<1	<1	<1	<1	<1	<1	<1
Sulfite ($SO3^-$)	mg/L	-	-	1.0	<0.5	1.0	1.0	<0.5	<0.5	1.0	1.0
Sulfide (as S)	mg/L	-	-	0.80	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Phenol compounds	mg/L	-	-	0.04	0.12	0.03	0.04	-	-	-	-
Fluoride (as F)	mg/L	-	-	0.49	0.43	0.37	0.41	-	-	-	-
Arsenic (as As)	mg/L	-	-	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	-	-	-	-
Cadmium (as Cd)	mg/L	-	-	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	-	-	-	-
Total Chromium (as Cr)	mg/L	-	-	0.03	0.02	0.06	0.055	-	-	-	-
Hexavalent chromium (as Cr)	mg/L	-	-	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	-	-	-	-
Copper (as Cu)	mg/L	-	-	0.01	ND (<0.02)	ND (<0.02)	ND (<0.02)	-	-	-	-
Lead (as Pb)	mg/L	-	-	0.082	0.071	0.125	0.087	-	-	-	-
Mercury (as Hg)	mg/L	-	-	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	-	-	-	-
Nickel (Ni)	mg/L	-	-	0.01	0.01	0.01	0.02	-	-	-	-
Selenium (Se)	mg/L	-	-	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	-	-	-	-
Zinc (as Zn)	mg/L	-	-	0.025	0.018	0.034	0.053	-	-	-	-
Iron (as Fe)	mg/L	-	-	4.1	3.6	6.4	10.0	-	-	-	-
Manganese (as Mn)	mg/L	-	-	ND (<0.05)	ND (<0.05)	0.067	0.095	-	-	-	-
Ammonia Nitrogen (NH_4-N)	mg/L	1.0	3.7	0.6	0.5	0.7	1.5	1.1	1.1	1.0	1.2
Nitrate Nitrogen (NO_3-N)	mg/L	-	-	0.8	1.4	0.9	0.9	0.2	0.7	0.8	0.4
Nitrite Nitrogen (NO_2-N)	mg/L	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Nitrogen (T-N)	mg/L	3.9	6.0	4.0	3.7	4.9	6.2	4.5	4.5	4.4	5.8
Phosphorous Phosphate (PO_4-P)	mg/L	-	-	0.06	0.05	0.07	0.1	0.08	0.07	0.08	0.11
Total Phosphorous	mg/L	0.52	0.45	-	-	-	-	-	-	-	-
Oil and Grease	mg/L	0.40	8.8	0.2	2.8	5.8	5.8	0.4	2.4	2.0	3.6
Fecal Coliform	CFU/100 ml	1040	4500	752	428	956	3200	870	790	910	1020

Note: ND = Non Detectable

Samples were measured and analyzed by ENPHO

River Water Quality - After Operation –

Parameter	Unit	June 09, 2005				June 28, 2005				July 21, 2005			
		RU	TK	RD	RD-2	RU	TK	RD	RD-2	RU	TK	RD	RD-2
Weather	_	Sunny	Sunny	Sunny	Sunny	Partially cloudy	Partially cloudy	Partially cloudy	Partially cloudy	Cloudy	Cloudy	Cloudy	Cloudy
Air temperaure	°C	30	30	30	30	30	30	31	30	28	28	27	27
Water temperature	°C	29	28	29	29	26	25	27	26	24	23	22	24
Discharge	m^3/sec	0.01	0.02	0.03	0.04	0.16	0.14	0.32	0.3	3.2	2.4	5.2	5.4
Color/appearance	_	Colorless	Colorless	Colorless	Colorless	Light grey	Light grey	Light grey	Light grey	Brown	Brown	Brown	Brown
Turbidity	NTU	<5	<5	<5	<5	20	20	20	20	100	75	100	100
Odor	_	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
pH	_	8.9	8.0	8.4	8.6	7.4	8.1	7.9	7.9	7.2	7.7	7.6	6.4
Electrical Conductivity (EC)	uS/cm	188	165	140	145	87	162	120	120	57	145	90	90
Dissolve Oxygen (DO)	mg/L	7.4	6.5	7.9	7.4	7.5	7.2	7.5	7.4	8.4	7.9	8.0	6.9
Total Dissolved Solids (TDS)	mg/L	63	111	102	103	106	128	95	94	38	96	42	64
Total Suspended Solids (TSS)	mg/L	3	3	3	3	26	5	3	9	73	74	474	70
Hydrogen Carbonate (HCO3$^-$)	mg/L	40.0	70.0	60.0	60.0	30.0	66.0	44.0	46.0	24.0	56.0	36.0	32.0
Biological Oxygen Demand (BOD)	mg/L	2.0	5.4	2.4	3.8	5.6	5.4	5.0	6.0	15.0	15.0	15.5	29.0
Chemical Oxygen Demand (COD)	mg/L	11.5	8.5	2.5	5.5	15.0	15.0	23.0	25.0	30.0	27.5	39.0	44.0
Oxidizability with $KMnO_4$ as O	mg/L	4.0	6.4	2.2	4.0	9.8	10.4	10.2	10.4	28.0	24.0	36.0	33.6
Chloride ion (Cl^-)	mg/L	3	2	3	3	5	4	4	4	1	1	1	1
Calcium (Ca++)	mg/L	11.2	23.3	16.8	24.9	28.0	25.0	20.0	24.0	8.0	19.2	12.8	14.4
Sodium (Na+)	mg/L	9.6	8.4	8.9	8.9	7.4	7.4	7.0	7.8	9.7	9.5	9.5	9.6
Sulfate (SO4$^-$)	mg/L	4.5	1.0	2.7	1.2	1.2	2.1	2.1	2.7	1.4	1.0	<1	<1
Sulfite (SO3$^-$)	mg/L	0.5	2.5	4.0	4.0	6.0	11.0	5.0	7.5	15.0	8.0	12.5	5.0
Sulfide (as S)	mg/L	0.8	ND (<0.4)	0.8	1.6	0.8	<0.4	<0.4	0.4	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)
Phenol compounds	mg/L	-	-	-	-	0.04	0.13	0.07	0.06	0.10	0.18	0.15	0.02
Fluoride (as F)	mg/L	-	-	-	-	0.06	0.06	1.55	ND (<0.05)	0.29	0.29	0.46	0.32
Arsenic (as As)	mg/L	-	-	-	-	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)
Cadmium (as Cd)	mg/L	-	-	-	-	0.001	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)
Total Chromium (as Cr)	mg/L	-	-	-	-	ND (<0.02)	0.027	ND (<0.02)	0.008	0.04	0.053	0.05	0.065
Hexavalent chromium (as Cr)	mg/L	-	-	-	-	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)
Copper (as Cu)	mg/L	-	-	-	-	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)
Lead (as Pb)	mg/L	-	-	-	-	0.016	0.019	0.007	0.019	0.15	0.17	0.12	0.14
Mercury (as Hg)	mg/L	-	-	-	-	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)
Nickel (Ni)	mg/L	-	-	-	-	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.02)	0.01	ND (<0.01)	ND (<0.01)	ND (<0.01)
Selenium (Se)	mg/L	-	-	-	-	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)
Zinc (as Zn)	mg/L	-	-	-	-	0.03	0.03	0.02	0.02	0.04	0.05	0.03	0.04
Iron (as Fe)	mg/L	-	-	-	-	1.43	1.69	1.68	1.45	3.95	3.14	3.41	4.38
Manganese (as Mn)	mg/L	-	-	-	-	0.08	0.11	0.08	0.06	0.13	0.11	0.15	0.13
Ammonia Nitrogen (NH_4-N)	mg/L	0.2	0.3	0.3	0.3	0.4	0.8	0.4	0.3	0.4	0.6	0.5	0.7
Nitrate Nitrogen (NO_3-N)	mg/L	0.2	0.3	0.3	0.2	0.6	0.3	0.3	0.4	ND (<0.05)	0.1	0.3	0.2
Nitrite Nitrogen (NO_2-N)	mg/L	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	ND (<0.01)
Total Nitrogen (T-N)	mg/L	2.3	2.3	2.5	3.0	3.0	3.0	3.3	3.1	2.6	2.8	3.1	3.9
Phosphorous Phosphate (PO_4-P)	mg/L	ND (<0.01)	0.11	0.08	0.07	0.09	0.09	0.09	0.08	0.08	0.14	0.09	0.04
Oil and Grease	mg/L	1.2	1.6	0.6	1.8	1.2	1.8	1.6	1.0	ND (<0.10)	ND (<0.10)	0.4	7.2
Fecal Coliform	CFU/100 ml	556	$193*10^3$	$13*10^4$	$7*10^3$	246000	3120	5800	4900	1900	2300	3200	3900

Note: ND = Non Detectable

Samples were measured and analyzed by ENPHO

Leachate Quality - After Operation –

Parameter	Unit	Lechate from outlet pipe			Lechate from pond		
		June 09, 2005	June 28, 2005	July 21, 2005	June 09, 2005	June 28, 2005	July 21, 2005
Weather	_	Sunny	Partiallly cloudy	Cloudy	sunny	Partiallly cloudy	Cloudy
Air temperaure	°C	30	31	28	29	31	28
lechate temperature	°C	23	24	26	35	27	25
Color/appearance	_	Faint Brown	light black	Light Black	Light black	Light Black	Black
Turbidity	NTU	150	1000	1000	500	1000	<2000
Odor	–	light pungent, faint sewage	foul sewage smell	leachate smell	odorless	faint sewage	leachate smell
pH	_	7.0	5.5	5.6	6.9	5.7	5.6
Electrical Conductivity (EC)	uS/cm	680	6620	8330	320	2600	4790
Dissolve Oxygen (DO)	mg/L	2.40	ND	ND	2.80	ND	ND
Total Dissolved Solids (TDS)	mg/L	446	3360	3476	260	2492	2004
Total Suspended Solids (TSS)	mg/L	62	870	13280	364	840	14010
Hydrogen Carbonate (HCO3-)	mg/L	164	1232	2400	84	380	1560
Biological Oxygen Demand (BOD)	mg/L	333	7750	27000	2100	5750	13800
Chemical Oxygen Demand (COD)	mg/L	525	11625	44500	2675	7900	25500
Oxidizability with KMnO4 as O	mg/L	496	8080	32000	2320	6200	16000
Chloride ion (Cl-)	mg/L	63	106	610	37	36	330
Calcium (Ca++)	mg/L	80.2	36.0	986.0	37.7	14.0	561.1
Sodium (Na+)	mg/L	39.2	360.9	385.6	20.8	133.4	259.0
Sulfate (SO4-)	mg/L	7.0	4.1	7.0	9.9	3.0	3.7
Sulfite (SO3-)	mg/L	34.0	26.0	55.0	26.0	10.0	81.0
Sulfide (as S)	mg/L	3.2	<0.4	36.0	2.4	13.0	32.0
Phenol compounds	mg/L	-	5.89	14.62	-	3.6	8.09
Fluoride (as F)	mg/L	-	0.06	0.30	-	ND (<0.05)	0.15
Arsenic (as As)	mg/L	-	0.012	0.017	-	0.012	0.060
Cadmium (as Cd)	mg/L	-	0.009	0.012	-	0.003	0.010
Total Chromium (as Cr)	mg/L	-	0.177	0.230	-	0.139	0.665
Hexavalent chromium (as Cr)	mg/L	-	0.020	0.040	-	0.030	0.040
Copper (as Cu)	mg/L	-	0.055	0.090	-	0.042	0.20
Lead (as Pb)	mg/L	-	0.126	0.550	-	0.065	0.570
Mercury (as Hg)	mg/L	-	ND (<0.01)	ND (<0.005)	-	ND (<0.01)	ND (<0.005)
Nickel (Ni)	mg/L	-	0.178	0.304	-	0.116	0.466
Selenium (Se)	mg/L	-	ND (<0.005)	ND (<0.005)	-	ND (<0.005)	ND (<0.005)
Zinc (as Zn)	mg/L	-	2.99	0.93	-	0.53	1.16
Iron (as Fe)	mg/L	-	117.3	195.6	-	23.3	244.5
Manganese (as Mn)	mg/L	-	10.29	12.03	-	4.33	9.51
Ammonia Nitrogen (NH4-N)	mg/L	6.9	321.4	144.7	9.6	125.7	97.3
Nitrate Nitrogen (NO3-N)	mg/L	2.8	21.2	8.6	4.3	1.5	6.8
Nitrite Nitrogen (NO2-N)	mg/L	0.1	0.0	0.0	0.1	0.0	0.0
Total Nitrogen (T-N)	mg/L	19.4	367.1	185.5	24.2	147.5	133.4
Phosphorous Phosphate (PO4-P)	mg/L	0.20	9.11	10.54	0.59	1.66	5.10
Oil and Grease	mg/L	8.40	126.20	37.00	22.22	72.20	27.00
Fecal Coliform	CFU/100 ml	$163*10^7$	$58*10^7$	$4*10^5$	$144*10^7$	$101*10^{10}$	$6*10^4$

Note: ND = Non Detectable

Samples were measured and analyzed by ENPHO

<u>Ditch Water Results - Before Operation –</u>

Parameter	Unit	27th July, 2004
olor	-	Light grey
Turbidity	NTU	50
Odor	-	Soily
Water temperature	oC	24.99
pH	-	7.64
Electrical Conductivity	us/cm	67.95
Dissolve Oxygen	mg/L	6.8
Biological Oxygen Demand	mg/L	14
Chemical Oxygen Demand	mg/L	19.62
Suspended Solids (SS)	mg/L	103
Total N	mg/L	2.63
NH4-N	mg/L	0.39
Total Phosphorous	mg/L	1.19
Chloride ion (Cl-)	mg/L	<1
Oil and Grease	mg/L	26.2
Fecal coliform	CFU/100ml	710

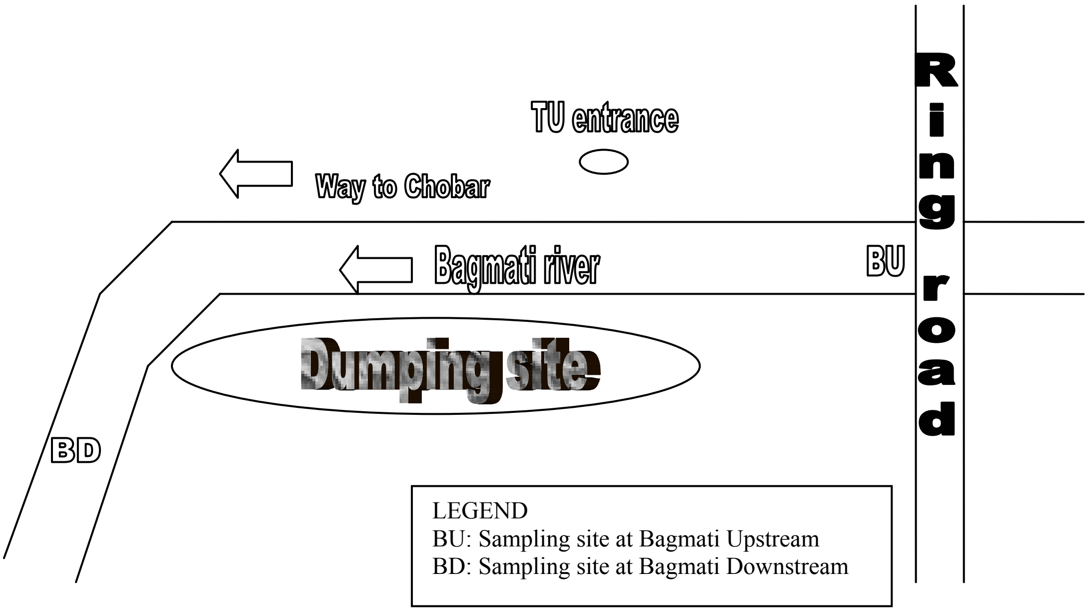
Note: Sample were monitored and analyzed by ENPHO

Out of three boreholes tested for ground water monitoring in July and August 2004, the water in borehole number 2 was found contaminated. Parameters such as BOD, COD and oxygen consumed as KMnO4 were found relatively high. The remaining two boreholes did not show such contamination. The two uncontaminated boreholes made suspect that there could be intentional contamination into the borehole 2 by trespassers. That could be because boreholes were open (no lid), there was not fencing around the boreholes and local people, cattle grazers, local kids and construction workers could be seen roaming around the boreholes. Moreover, the construction workers also had informed us that some trespassers had mixed dirty soil into that borehole.

The value of BOD, COD and KMnO4 consumed is directly related to amount of organic matter in sample. If a sample contains high concentration of organic compound, the BOD, COD value and KMnO4 consumed becomes high. The source of higher amount of organic matter in that borehole was intentional mixing of dirty soil, leaf litter, urine and fecal matter by trespassers. Later on, to prevent such intentional contamination of the boreholes, they were capped, screwed. After cleaning up the borehole, sample was again collected and the results showed not much difference among the three boreholes. Quality of the ground water in all three boreholes were similar.

6. Leachate and River Water Quality at Bagmati Dumping Site

Besides the monitoring at Sisdol S/T-LFS, the Bagmati River and leachate quality was surveyed at a dumping site in the bank of the Bagmati River at Sundarighat for the reference. The Bagmati River water samples were collected from upstream and downstream of the dumping site, and leachate samples were collected from the dumping site. Some parameters were also measured on site. Two types of leachates were collected: leachate coming out of fresh municipal dump, and leachate coming out of old waste which was dumped there previously. The river sampling was conducted on July 27, 2004 and leachate sampling was done on July 30, 2004. Methods of field measurements and laboratory analysis were similar to the monitoring for Sisdol S/T-LFS. All locations are shown in the map below and the results are shown in the following tables.



Sampling Location on Water Quality Test at Bagmati River Dumping Site

Leachate Quality

Parameter	Unit	Leachate near fresh dump (leachate 1)	Leachate near old dump (leachate 2)
Color	-	Light black	Light black
Turbidity	NTU	700	600
Odor	-	Sewage	Sewage
Lechate Temperature	oC	25.81	28.32
pH	-	6.21	6.31
EC	Us/cm	4293	320.3
DO	mg/L	0	0
BOD	mg/L	3600	2450
COD	mg/L	5232	41420
Suspended Solids (SS)	mg/L	438	2388
Total N	mg/L	118.85	45.39
NH4-N	mg/L	93.26	20.97
Total P	mg/L	8.70	7.40
Chloride ion (Cl-)	mg/L	205	30
Oil and Grease	mg/L	24.20	1460.20
Fecal Coliform	CFU/100ml	$285*10^4$	$255*10^4$

Note: Sample were monitored and analyzed by ENPHO

Bagmati River Water Quality

Parameter	Unit	Bagmati River upstream from dumping site (BU)	Bagmati River downstream from dumping site (BD)
Color	-	Grey	Grey
Turbidity	NTU	1000	1000
Odor	-	Very little odor	Very little odor
Water temperature	oC	24.38	24.56
pH	-	7.07	7.16
EC	us/cm	108	129
DO	mg/L	5.5	5.9
BOD	mg/L	25	24
COD	mg/L	82.84	76.74
Suspended Solids (SS)	mg/L	764	370
Total N	mg/L	13.07	10.27
NH4-N	mg/L	5.86	2.20
Total P	mg/L	1.01	0.91
Chloride ion (Cl-)	mg/L	8	8
Oil and Grease	mg/L	2.20	16.9
Fecal coliform	CFU/100ml	$155*10^2$	$456*10^2$

Note: Sample were monitored and analyzed by ENPHO

Leachate produced at landfill which have recently been filled (Acetogenic leachates) tend to have high concentration of BOD and high BOD:COD ratios, where as lechate produced at older landfill (Methanogenic leachates) tend to have relatively lower concentration of BOD, and low BOD:COD ratios (Hallett et. al 2002; Robinson 1995; Knox 1993). In this case also, leachate analysis at Bagmati dumping site shows similar results. It is not abnormal to see too high COD values (in thousands) in old landfill leachates. For example, Lagerkvist and Kylefors (1993) have shown that COD of landfill leachate dominated by wet compostable household waste can go up to 35000 mg/L. Studies have shown that around 70% of the solid waste that is dumped by Kathmandu Metropolitan City is compostable household waste (Shrestha, 2005). So, it is not amazing to see COD value of 41,420 mg/L in Leachate 2.

The color of the water in the Bagmati River was light black due to mixing of residential sewage, industrial effluents and eroded soil from Bagmati watershed. Unlike other rivers in hills of Nepal which look clear in non-rainy seasons, Bagmati water looks black even during non-rainy season due to mixing of sewage and industrial effluents into the river. Turbidity was quite high at both sampling locations. The high turbidity was due to the presence of colloidal solids. The water did not smell bad at both locations. It is possible that the river did not smell bad due to high volume of water during monsoon in which effluents and sewage were diluted. Results of the parameters there were measured show that the quality of water at both upstream and downstream was very poor.

PILOT PROJECT E

DEVELOPMENT OF OPERATION AND MANAGEMENT CAPACITIES

Pilot Project E-1

Result of Solid Waste Quantity and Quality Survey (I)

Table of Contents

CHAPTER 1 FINDINGS AND ANALYSIS

1.1 General

The literature on solid waste management, based on the results of other least developed countries, states that the domestic waste generation rate is usually in between 0.2 to 0.6 kg/capita/day, and commercial waste is around 30 to 40 % of total waste.

A report prepared by Lohani and Thani, 1978, states the waste generation rate of Kathmandu was 0.25 kg/capita/day. A report published by Solid Waste Management Project in 1985 states the value of waste generation in KMC to be 0.45/capita/day, though this figure seems relatively higher than the actual generation rate.

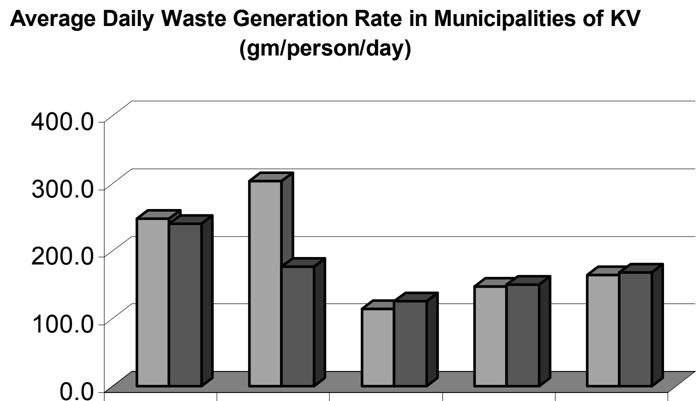
1.2 Results of Quantity Survey of Household Waste

The average waste generation and bulk density in the five municipalities of the Kathmandu Valley surveyed in September, 2004 is presented in following Table 1.2-1 and represented graphically in Figure 1.2-1.

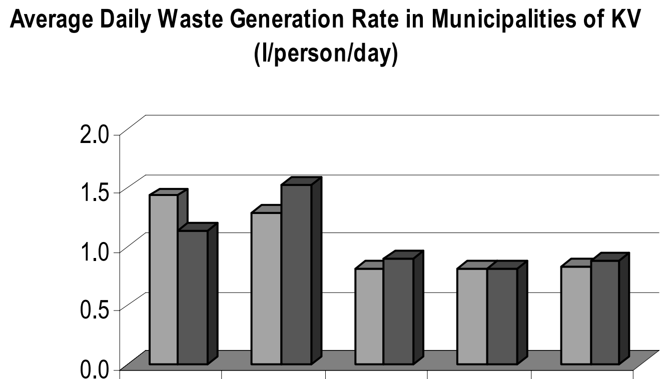
Table 1.2-1 Average Waste Generation and Bulk Density of the Waste

Munici-palities	Income Level	Weekdays			Weekend		
		Waste generation per person weight (g/person)	Waste generation per person volume (l/person)	Bulk density (g/l)	Waste generation per person weight (g/person)	Waste generation per person volume (l/person)	Bulk density (g/l)
KMC	HI	332.27	1.53	217.04	286.70	1.35	212.51
	MI	239.78	1.51	158.61	261.33	1.12	234.11
	LI	179.90	1.15	156.40	153.03	0.93	163.85
	Average	**247.93**	**1.43**	**173.85**	**240.6**	**1.13**	**213.12**
LSMC	HI	204.10	1.24	164.54	262.46	1.51	173.31
	MI	397.60	1.02	390.66	150.50	1.02	147.50
	LI	216.03	1.88	114.88	145.53	2.54	57.40
	Average	**303.83**	**1.29**	**235.69**	**177.25**	**1.52**	**116.41**
BKM	HI	134.26	0.93	144.93	124.01	1.04	119.45
	MI	116.19	0.85	136.65	134.59	0.93	145.10
	LI	92.42	0.63	145.62	109.44	0.70	155.59
	Average	**114.76**	**0.82**	**140.75**	**125.66**	**0.90**	**139.75**
KRM	HI	119.06	0.72	164.60	132.89	0.81	164.63
	MI	160.67	0.86	186.36	169.39	0.80	211.82
	LI	150.36	0.80	187.02	130.81	0.82	160.13
	Average	**147.69**	**0.81**	**181.68**	**150.62**	**0.81**	**186.90**
MTM	HI	178.07	0.81	218.88	193.41	0.82	235.32
	MI	151.22	0.76	199.60	150.33	0.78	192.64
	LI	176.20	0.99	177.78	179.66	1.12	160.68
	Average	**164.18**	**0.83**	**197.81**	**168.43**	**0.88**	**192.45**

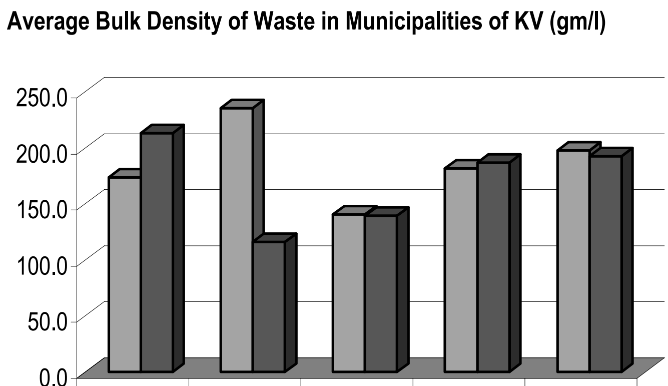
Note: HI=high income, MI=Middle income, LI=Low income
Source: JICA Study Team, September 2004



	KMC	LSMC	BKM	KRM	MTM
Weekday	247.9	303.8	114.8	147.7	164.2
Weekend	240.6	177.3	125.7	150.6	168.4



	KMC	LSMC	BKM	KRM	MTM
Weekday	1.4	1.3	0.8	0.8	0.8
Weekend	1.1	1.5	0.9	0.8	0.9

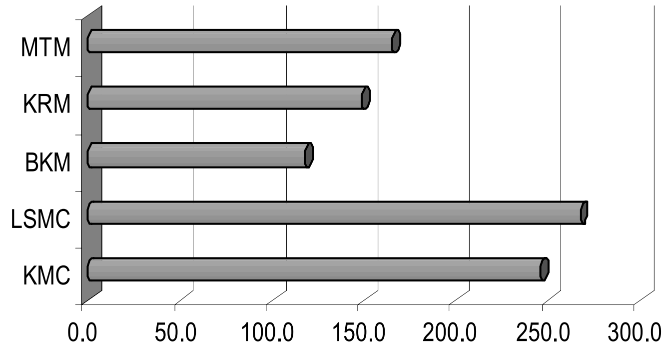


	KMC	LSMC	BKM	KRM	MTM
Weekday	173.9	235.7	140.8	181.7	197.8
Weekend	213.1	116.4	139.8	186.9	192.5

Figure 1.2-1 Average Waste Generation and Bulk Density In Kathmandu Valley

Source: JICA Study Team, September 2004

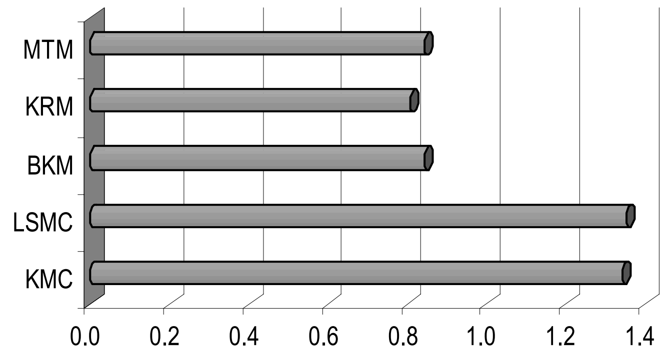
The average household waste generation rate of the five municipalities in terms of weight is presented in Figure 1.2-2. Similarly, the average household waste generation rate in terms of volume (L/person/day) is presented in Figure 1.2-3. Bulk density is also presented in gm/L in Figure 1.2-4.



	KMC	LSMC	BKM	KRM	MTM
Waste generation per person weight (g/person)	245.8	267.7	117.9	148.5	165.4

Figure 1.2-2 Average Household Waste Generation Rate (gm/person/day) in the Kathmandu Valley

Source: JICA Study Team, September 2004



	KMC	LSMC	BKM	KRM	MTM
Waste generation per person volume (l/person)	1.3	1.4	0.8	0.8	0.8

Figure 1.2-3 Average Household Waste Generation Rate (L/person/day) in the Kathmandu Valley

Source: JICA Study Team, September 2004

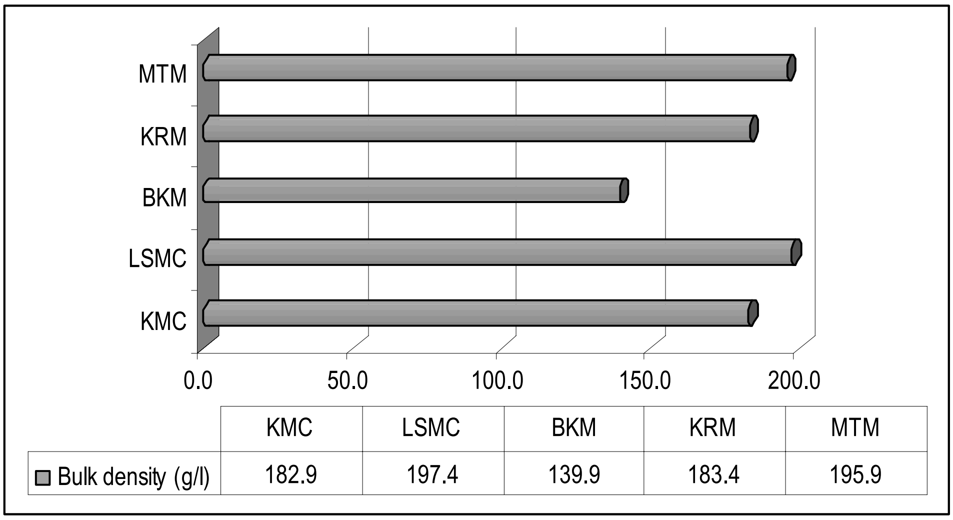


Figure 1.2-4 Average Household Waste Bulk Density (gm/L) in the Kathmandu Valley

Source: JICA Study Team, September 2004

The Figure 1.2-3 indicates that the unit waste generation rate (UGR) in LSMC is higher than other municipalities, although the socio-economic characteristics of LSMC are almost similar to KMC. The survey result suggests that the unit generation rate of middle-income and low-income households in weekdays is higher than that of KMC. One of the reasons for higher value of waste generation rate in LSMC could be due to higher % of kitchen waste in LSMC than that of KMC, due to which weight of waste has increased.

1.3 Comparison of Past Surveys

A comparison of household waste generation among the survey by KMC in 2001, JICA Study in April, 2004 and this survey (Sept., 2004) is presented below in Table 1.3-1.

Table 1.3-1 Comparison of the Waste Generation in KMC Estimated during Various Surveys (gm/person/day)

Waste Generation	KMC Survey	April, 2004 Wet Season Survey	Sep-Nov, 2004 (avg. of five municipalities) Dry Season Survey
Generation: g/person	240	198	245.8
Generation: liter/person	1.04	0.8	1.3
Density: g/liter	231	241	182.9

Source: KMC Survey 2001 and JICA Survey, 2004 (April and Sep-Nov, 2004)

The result of this survey (Sept., 2004) is comparable to the estimated generation rate of KMC Survey. This survey result is higher than the wet season survey by the JICA Study Team in April, 2004. It should be noted that the dry season survey included 7,000 samples, and is expected to be the most representative and accurate.

The above table also indicates that bulk density estimated based on the dry season survey is less than both the results of other surveys.

1.4 Results of Quantity Survey of Commercial Waste

The unit generation of commercial waste based on analysis of this survey is presented in Table 1.4-1 and Figure 1.4-1.

Table 1.4-1 Unit Generation Rate of Commercial Waste

Municipality	Source of waste generation	Weekdays			Weekend			Total Average		
		Waste generation per Unit weight (g)	Waste generation per Unit volume (l)	Bulk density (g/l)	Waste generation per Unit weight (g)	Waste generation per Unit volume (l)	Bulk density (g/l)	Waste generation per Unit weight (g)	Waste generation per Unit volume (l)	Bulk density (g/l)
KMC	Hotel/ restaurants	3,311.26	11.06	299.26	2672.69	11.15	240.52	3,128.81	11.08	282.48
	Market	475.20	4.50	104.70	423.00	5.80	72.60	460.29	4.87	95.53
	Office	186.20	3.23	54.73	100.70	2.52	38.62	161.77	3.03	50.12
LSMC	Hotel/ restaurants	2,030.22	12.60	160.27	2213.75	13.32	165.85	2,082.66	12.81	161.86
	Market	1,312.07	7.78	168.65	237.33	6.08	39.04	1,005.00	7.29	131.62
	Office	854.63	9.13	94.74	400.38	7.39	38.11	749.16	9.01	83.45
BKM	Hotel/ restaurants	3,100.89	14.31	205.17	3865.71	16.14	225.30	3,319.41	14.84	210.92
	Market	1,076.57	7.09	151.94	1120.71	6.18	181.39	1,089.18	6.83	160.35
	Office	1,185.49	9.30	127.48	419.29	3.81	89.87	966.57	7.73	116.73
MTM	Hotel/ restaurants	2,356.20	11.84	199.00	2546.50	13.00	195.88	2,410.57	12.17	198.11
	Market	807.00	8.12	99.38	811.00	8.20	98.90	808.14	8.14	99.24
	Office	658.26	8.22	70.87	465.50	5.70	72.99	603.18	7.50	71.47
KRM	Hotel/ restaurants	3,480.20	16.88	206.12	3865.71	16.14	225.30	3,561.57	17.34	205.37
	Market	1,757.00	13.44	130.73	1120.71	6.18	181.39	2,354.29	15.95	142.81
	Office	566.40	6.09	93.21	419.29	3.81	89.87	528.28	5.11	131.87

Source: JICA Study Team, 2004 (April and Sep-Nov, 2004)

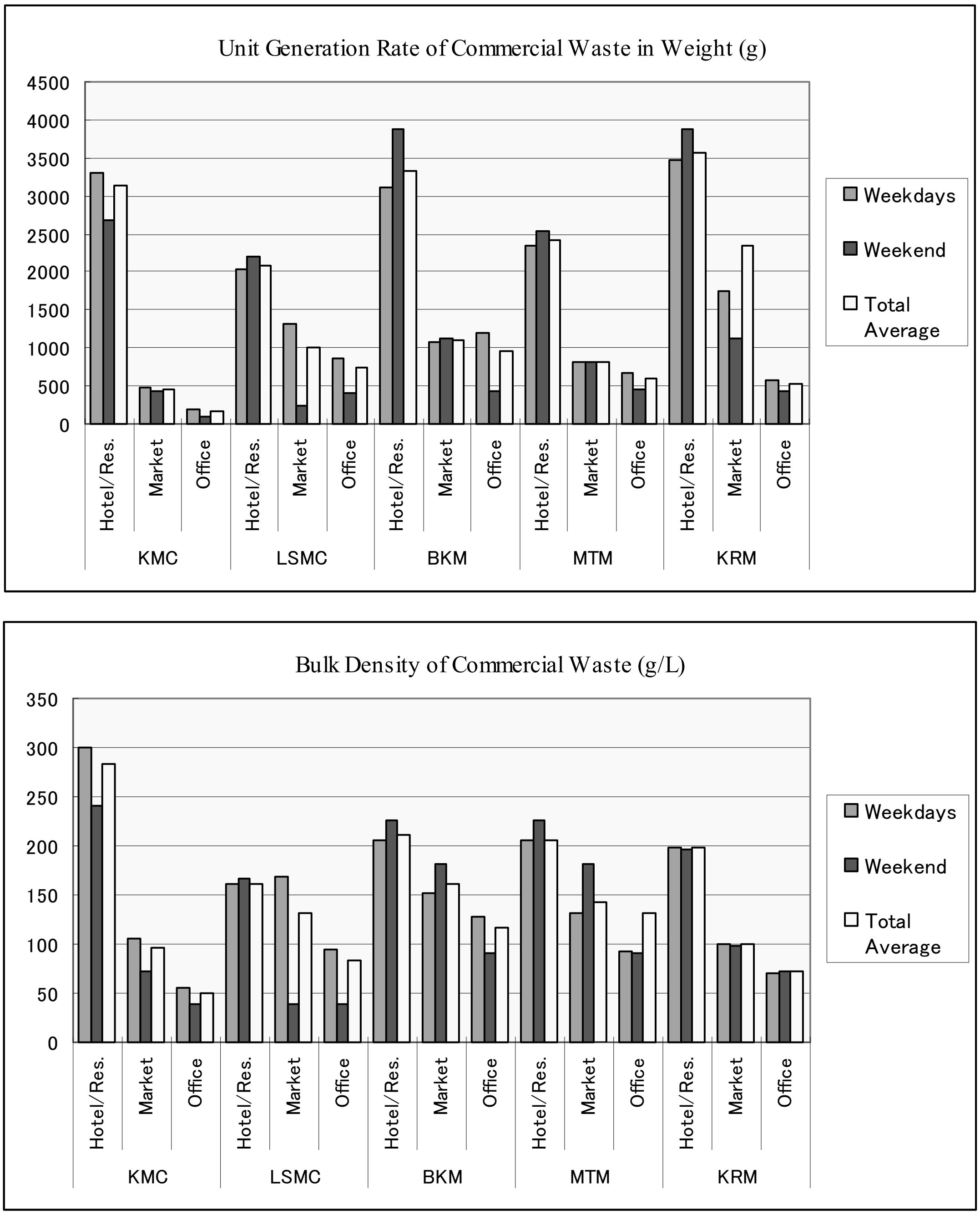


Figure 1.4-1 Unit Generation Rate of Commercial Waste

Source: JICA Study Team, 2004 (April and Sep-Nov, 2004)

Unit generation from different categories of hotels and restaurants varies a lot as the size of the sampled hotels and restaurants also varied. Similarly, there is a large variation in waste generation among different categories of the offices and markets. This is attributed to variation in their business scale and type, and economic transaction.

1.5 Results of Quality Survey of Household Waste

All the municipalities have made attempts in past to estimate waste characteristics. On the basis of their estimation, more than two third of the waste was organic matter, basically kitchen waste in all the municipalities. Other major components were paper and plastic. Glass, metal, rubber and leather, wood and leaves were also the waste compositions, but in lower percentage. The solid waste quality provided by each municipality and the findings of this survey (September, 2004) are presented in Table 1.5-1. Clay pots and foam contribute major item in the composition of wastes categorized as *Others*.

Table 1.5-1 Characteristics of Household Waste in Five Municipalities

Municipalities / Waste Components	KMC % by weight			LSMC % by weight			BKM % by weight			KRM % by weight			MTM % by weight		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Organic	70	71.9	70.9	67.5	68.4	78.8	76	85.7	87.0	74	84.1	80.2	75	79.7	84.9
Paper	9	10.6	10.1	8.8	6.9	9.0	3.25	5.1	3.3	5.7	3.0	5.5	6	1.0	6.5
Textile	3	2.4	1.9	3.6	2.4	0.9	3	0.7	0.9	0.8	3.9	1.3	-	0.0	0.8
Wood & Leaves	-	2.7	3.5	0.6	10.6	2.0	-	1.6	1.0	0.09	0.9	2.5	-	0.0	1.3
Plastic	9	9.1	6.7	11.4	13.1	7.0	3.4	6.1	3.3	8.8	7.9	6.1	5	4.0	5.5
Rubber/Leather	1	1.6	0.0	0.3	0.0	0.1	-	0.0	0.0	2.52	0.0	0.0	2	0.0	0.0
Metals	1	0.3	0.6	0.9	1.7	0.3	0.3	0.0	0.3	1.9	0.0	0.6	3	0.0	0.4
Glass	3	0.0	4.9	1.6	4.0	1.0	1.5	0.0	2.1	2.9	0.0	2.7	2	1.0	0.2
Ceramics	-	0.7	0.1	0.0	0.0	0.3	-	0.0	0.0	-	0.0	0.0	-	0.0	0.0
Others	0.9	0.0	1.4	5.3	0.0	0.6	12.55	0.0	2.1	3.29	0.0	1.1	7	0.0	0.4
Total	**100**			**100**			**100**			**100**			**100**		

Note: 1- Information provided by each municipality.
2- Result of JICA Study Survey, April, 2004 (Dry Season)
3- Result of JICA Study Survey, Sept.-Nov., 2004 (Wet Season)
Source: JICA Study Team, September 2004

The above Table 1.5-1 shows the percentage composition of various components of the household waste for the five municipalities of the Kathmandu Valley. The results of this wet season survey almost resembles with the past studies. The wet season data is higher than the dry season, which is due to increase in moisture content.

Weighted average composition of different components in the waste of the five municipalities is presented in Figure 1.5-1.

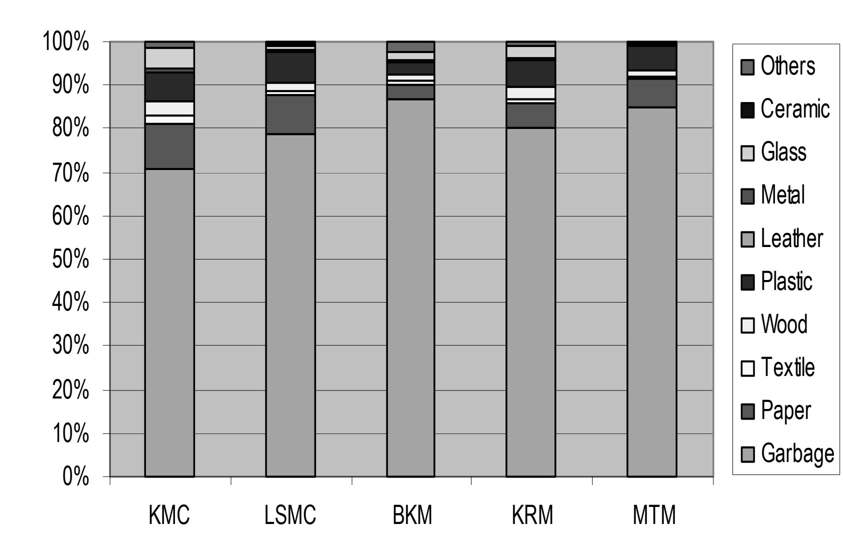
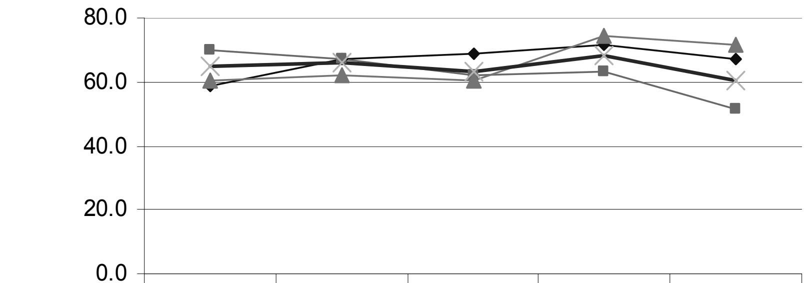


Figure 1.5-1 Average Composition of Household Waste of the Five Municipalities

Source: JICA Study Team, September 2004

The moisture content of the household waste of the respective municipalities and their average are presented in Figure 1.5-2.



	KMC	LSMC	BKM	KRM	MTM
HI	58.7	67.4	69.0	71.5	67.3
MI	69.7	67.2	62.2	63.3	51.7
LI	60.6	62.3	60.5	74.3	71.6
Average	64.7	66.0	63.4	68.1	60.6

Figure 1.5-2 Average Moisture Content of Household Waste of the Five Municipalities (%)

Source: JICA Study Team, September 2004

1.6 Results of Quality Survey of Commercial Waste

Table 1.6-1 presents the weighted average in % of the composition of commercial waste in the five municipalities of the Kathmandu Valley. The graphical representation of the composition is presented in Figure 1.6-1.

Table 1.6-1 Composition of Commercial Waste of the Five Municipalities

Municipalities	KMC	LSMC	BKM	MTM	KRM
Waste Component	% by weight	% by weight	% by weight	% by weight	% by weight
Organic	37.0	41.8	71.5	72.1	76.2
Paper	36.7	44.1	20.5	13.5	13.2
Textile	1.7	0.6	0.8	6.1	1.9
Wood & Leaves	2.0	0.2	0.2	0.4	0.2
Plastic	12.1	9.8	3.6	7.3	7.2
Rubber/Leather	0	0.0	0.0	0.1	0.1
Metal	1.2	0.6	1.0	0.2	0.4
Glass	6.7	1.6	2.1	0.0	0.0
Ceramics	1.8	0.5	0.0	0.0	0.0
Others	0.9	0.9	0.2	0.3	0.8
Total	100	100	100	100	100

Source: JICA Study Team, September 2004

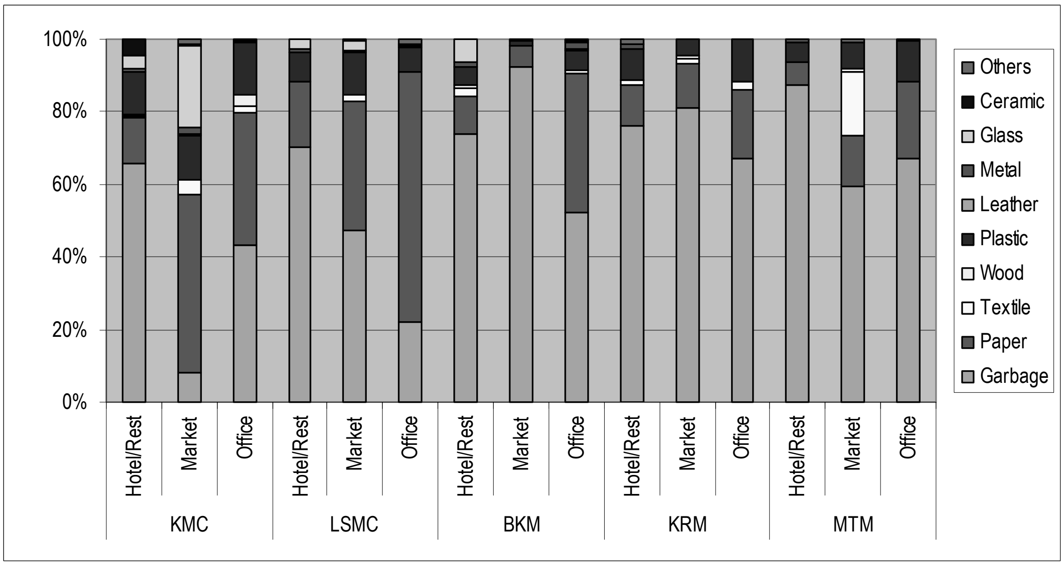
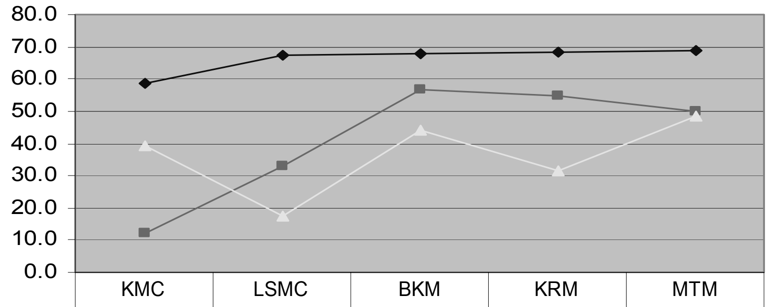


Figure 1.6-1 Average Composition of Commercial Waste of the Five Municipalities (%)

Source: JICA Study Team, September 2004

The moisture content of the commercial waste of different municipalities are presented in following Figure 1.6-3.



	KMC	LSMC	BKM	KRM	MTM
Hotel/Res	58.5	67.2	67.8	68.6	69.0
Market	12.3	32.9	56.7	54.7	49.9
Office	39.4	17.3	44.3	31.6	48.4

Figure 1.6-3 Average Moisture Content of Commercial Waste of the Five Municipalities (%)

Source: JICA Study Team, 2004

As shown in Figure 1.6-3, the moisture content of market in KMC is estimated to be relatively low. This is mainly because percentage of waste collected in the market was relatively low. The shops sampled were mostly cold store, stationary, pharmacy, provision shops, etc., which did not generate the solid waste with higher moisture content. The vegetable shops under the sampling were less in numbers. Consequently, the moisture content of the market of KMC is estimated to be low.

The characteristics of the street waste of the three municipalities, KMC, LSMC and BKM, are presented hereunder.

Table 1.6-2 Characteristics of Street Waste

Municipalities	KMC		LSMC		BKM	
Parameters	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Waste Generation (g/m.)	419.5	260	386.08	345.74	106.4	94.5
Bulk Density (g/l)	924.6	611.7	280.42	284.09	276.6	265.2

Source: JICA Study Team, 2004 (April and Sep-Nov, 2004)

The bulk density of the street waste of KMC is estimated to be higher than that of LSMC and BKM. This may be due to higher amount of dust and inert material of the street waste of KMC. Nevertheless, the value of LSMC should be taken as reference, based on similar socio-economic characteristics of the two cities of LSMC and KMC.

1.7 Total Waste Generation in the Five Municipalities of the Kathmandu Valley

The total waste generation in the five municipalities of the Kathmandu Valley is estimated and discussed hereunder. The basis for the estimation of the total generation is as follows.

- The household generation per person per day is based on the analysis of survey carried out during wet season.
- The commercial waste generation rate per unit per day is based on the analysis of survey carried out during wet season.
- The household waste is estimated by multiplying total population projected to year 2004 with the household waste unit generation rate.
- The commercial waste generation is estimated through multiplying total number of units

with the rate of waste generation from similar units. The total number of commercial units of KMC is based on the year 2000 data of the Kathmandu Valley Mapping Project (KVMP). For LSMC, no such database is available with the municipality. Thus, an attempt has been made to estimate the number of commercial units with respect to population of KMC and LSMC, assuming similar socio-economic characteristics. Also, in case same type of sample is not included in the sample of LSMC, the unit generation rate is taken as that of KMC.

- For BKM, MTM and KRM, the number of commercial units have been obtained based on the discussions with the ex-municipal ward chairpersons, who know how many commercial units exist in their wards. Similarly, unit generation rate of different units not included in the sample of certain municipality are also referred among each other based on similar socio-economic characteristics.
- Department store was not included in the sampling during survey. Thus, estimation has been made that a large department store, in general, caters to at least 20 times more customers than general shops. Accordingly, the generation of daily waste of general shop has been multiplied 20 times.
- Length of municipal street to estimate daily waste generation has been based on either municipal data or Nepal Road Statistics, 2002 published by Department of Roads. Waste generation rate for street of MTM and KRM is considered as that of KMC.

1.7.1 Total Waste Generation in Kathmandu Valley

The total waste generation in the five municipalities of the Kathmandu Valley is given in Table 1.7-1 and Figure 1.7-1. The waste generation in the respective municipalities is presented in the following Sub-sections.

Table 1.7-1 Total Waste Generation in the Kathmandu Valley (MT)

Municipalities	Daily Waste Generated in MT
KMC	311.1 (71.3%)
LSMC	76.9 (17.6%)
BKM	21.9 (5.0%)
KRM	11.7 (2.7%)
MTM	14.6 (3.3%)
Total	436.1

Source: JICA Study Team, September 2004

1.7.2 Waste Brought from Surrounding VDCs in Municipal Area

The Village Development Committees (VDCs) surrounding municipal areas and lying at it's fringe has a practice of collecting waste from their street side and transport it to the adjacent municipal area and dump there. Such waste is being managed by the concerned municipalities. The results of the survey, which was conducted with due discussion with the concerned officials of the VDCs are shown in Table1.7-2.

Table 1.7-2 Incoming Waste to Municipality from Surrounding VDCs

Municipality	Incoming Waste from Surrounding VDCs (ton)
KMC	23.4
LSMC	3.6
BKM	6.3

Source: JICA Study Team, September 2004

The waste coming from VDCs into the municipal area is significant in the case of KMC. Similarly, the waste incoming into LSMC is lower than that of BKM. Out of total waste generated in the municipality, KMC observes 12 %, LSMC 5 % and BKM 29 % of waste from surrounding VDCs. This is due to less number of VDCs surrounding the LSMC. Also, the VDCs surrounding KMC and BKM have more urban expansion. It should be noted that 1,400 kg weight of waste of each tractor has been considered for estimation of total waste incoming from VDCs. This weight has been determined from the average weight weighed at Sundarighat during June, 2005 under the Study.

1.7.3 Total Waste Generation in KMC

Table 1.7-3 presents the estimate of total waste generation in KMC.

Table 1.7-3 Total Waste Generation in KMC

S.N.	Category of Waste Generation	Unit Generation	Unit	Number	Total Waste in gm	Total Waste in ton
1.0	**Household**					
	Households Generation	245.8		741,008	182,169,407	182.17
2.0	**Commercial Waste**					
2.1	**Hotel and Restaurant**					
	Hotel and Restaurant (A)	3,459.0	gm/ H&R	1,527	5,281,863	5.28
	Hotel and Restaurant (B)	2,789.9	gm/ H&R	368	1,026,669	1.03
	Hotel and Restaurant (C)	2,672.9	gm/ H&R	164	438,349	0.44
	Hotel and Restaurant (X)	3,383.3	gm/ H&R	109	368,783	0.37
	Hotel and Restaurant (Y)	66,400.0	gm/ H&R	59	3,917,600	3.92
	Hotel and Restaurant (Z)	1,000,000.0	gm/ H&R	24	24,000,000	24.00
2.2	**Market**					
	Market (A)	460.3	gm/Market	23,570	10,848,800	10.85
	Market (B)	9,205.6	gm/Market	15	138,084	0.14
2.3	**Office**					
	Office Type A	177.6	gm/office	292	51,845	0.05
	Office Type B	232.1	gm/office	293	68,017	0.07
	Office Type C	32.5	gm/office	784	25,480	0.03
	Office Type D	252.5	gm/office	103	26,008	0.03
	Office Type E	12.8	gm/office	194	2483	0.00
3.0	**Street**	**210.9**	**gm/meter**	**219,500**	**4,629,2550**	**46.29**
4.0	**Waste from nearest VDCs**					**36.40**
Total						**311.1**

Source: JICA Study Team, September 2004

The above table indicates that household waste generation contributes 58%, commercial source contributes 15%, street waste contributes 15% and waste from surrounding VDCs dumped in the municipal area is 12% of the total waste generation in KMC.

1.7.4 Total Waste Generation in LSMC

Table 1.7-4 presents the estimate of total waste generation in LSMC.

Table 1.7-4 Total Waste Generation in LSMC

S.N.	Category of Waste Generation	Unit Generation	Unit	Number	Total Waste in gm	Total Waste in ton
1.0	**Household Waste**					
1.1	Households Generation	267.7	Nos	178,987	47,914,820	47.91
2.0	**Commercial Waste**					
2.1	**Hotel and Restaurant**					
	Hotel and Restaurant (A)	2,017.2	gm/H&R	368	742,313	0.74
	Hotel and Restaurant (B)	2,803.4	gm/H&R	89	249,501	0.25
	Hotel and Restaurant (C)	2,672.9	gm/H&R	39	104,243	0.10
	Hotel and Restaurant (X)	3,383.3	gm/H&R	26	87,966	0.09
	Hotel and Restaurant (Y)	66,400.0	gm/H&R	6	398,400	0.40
	Hotel and Restaurant (Z)	1,000,000.0	gm/H&R	1	1,000,000	1.00
2.2	**Market**					
	Market (A)	1,005.0	gm/Market	5,693	5,721,465	5.72
	Market (B)	20,100.0	gm/Market	5	100,500	0.10
2.3	**Office**					
	Office Type A	306.5	gm/office	70	21,455	0.02
	Office Type B	251.4	gm/office	70	17,601	0.02
	Office Type C	457.2	gm/office	189	86,411	0.09
	Office Type D	1,290.5	gm/office	25	32,264	0.03
	Office Type E	12.8	gm/office	46	589	0.00
3.0	**Street (A)**	**209.8**	**gm/meter**	**84,000**	**17,619,000**	**17.62**
4.0	**Waste from nearest VDCs**					**3.60**
	Total					**76.86**

Source: JICA Study Team, September 2004

The above table indicates that household waste generation contributes 62%, commercial source contributes 11%, street waste contributes 22% and waste from surrounding VDCs dumped in municipal area is 5 % of the total waste generation in LSMC.

1.7.5 Total Waste Generation in BKM

Table 1.7-5 presents the estimate of total waste generation in BKM.

Table 1.7-5 Total Waste Generation in BKM

S.N.	Category of Waste Generation	Unit Generation	Unit	Number	Total Waste in gm	Total Waste in ton
1.0	**Household Waste**					
1.1	Households Generation	117.9	Person	80,476	9,674,088	9.5
2.0	**Commercial Waste**					
2.1	Hotel and Restaurant					
	Hotel and Restaurant (A)	2,451.4	gm/H&R	298	730,502	0.7
	Hotel and Restaurant (B)	939.5	gm/H&R	53	49,794	0.0
	Hotel and Restaurant (C)	7,118.9	gm/H&R	20	142,378	0.1
	Hotel and Restaurant (X)	3,264.9	gm/H&R	22	71,829	0.1
2.2	**Market**					
	Market (A)	1,098.6	gm/Market	3,696	4,060,584	4.1
2.3	**Office**					
	Office Type A	637.1	gm/office	53	66,462	0.1
	Office Type B	1,215.7	gm/office	49	70,323	0.1
	Office Type C	110.9	gm/office	168	240,127	0.2
	Office Type D	1,223.0	gm/office	126	180,096	0.2
	Office Type E	786.1	gm/office	18	25,728	0.0
3.0	**Street (A)**	**51.3**	**gm/meter**	**22,500**	**458,050**	**0.5**
4.0	**Waste from nearest VDC**					**6.3**
Total						**21.88**

Source: JICA Study Team, September 2004

The above table indicates that household waste generation contributes 43 %, commercial source contributes 26%, street waste contributes 2% and waste from surrounding VDCs dumped in municipal area is 29% of the total waste generation in BKM.

1.7.6 Total Waste Generation in MTM

Table 1.7-6 presents the estimate of total waste generation in MTM.

Table 1.7-6 Total Waste Generation in MTM

S.N.	Category of Waste Generation	Unit Generation	Unit	Number	Total Waste in gm	Total Waste in ton
1.0	**Household Waste**					
	Households Generation	165.4	gm/Person	53,853	8,955,952	8.91
2.0	**Commercial Waste**					
2.1	**Hotel and Restaurant**					
	Hotel and Restaurant (A)	2,451.4	gm/H&R	267	654,511	0.65
	Hotel and Restaurant (B)	939.5	gm/H&R	14	13,153	0.00
	Hotel and Restaurant (C)	7,118.9	gm/H&R	4	28,476	0.00
	Hotel and Restaurant (x)	3,264.9	gm/H&R	3	9,795	0.00
2.2	**Market**					
	Market (A)	809.0	gm/Market	550	444,950	0.44
2.3	**Office**					
	Office Type A	330.3	gm/office	27	8,917	0.01
	Office Type B	139.8	gm/office	54	7,547	0.01
	Office Type C	110.9	gm/office	51	5,657	0.01
	Office Type D	1,223.0	gm/office	55	67,265	0.07
	Office Type E	786.1	gm/office	11	8,648	0.01
3.0	**Street (A)**	**210.0**	**gm/meter**	**21,500**	**4,515,000**	**4.52**
4.0	**Waste from Surrounding VDC**					
Total						**14.6**

Source: JICA Study Team, September 2004

1.7.7 Total Waste Generation in KRM

Table 1.7-7 presents the estimate of total waste generation in KRM. It should be noted that waste generation rate of those units are referred from Bhaktapur Municipality, which resembles more in socio-economic characteristics. The weighted % in terms of population has been considered.

For generation rate of street waste, the similar rate of KMC has been considered. Also as the rate of waste generation during weekend in KRM from Market is found to be too high, this value is not considered, and only weekday rate of generation is considered to calculate the waste generation.

Table 1.7-7 Total Waste Generation in KRM

S.N.	Category of Waste Generation	Unit Generation	Unit	Number	Total Waste in gm	Total Waste in ton
1.0	**Household Waste**					
1.1	Households Generation	148.5	gm/person	43,424	6,448,464	6.45
2.0	**Commercial Waste**					
2.1	**Hotel and Restaurant**					
	Hotel and Restaurant (A)	3561.6	gm/H&R	65	231,502	0.23
	Hotel and Restaurant (B)	506.9	gm/H&R	14	7,097	0.01
	Hotel and Restaurant (C)	3841.3	gm/H&R	4	15,365	0.02
2.2	**Market**					
	Market (A)	1,757.0	gm/Market	420	737,940	0.74
2.3	**Office**					
	Office Type A	592.8	gm/office	35	21,858	0.02
	Office Type B	624.5	gm/office	34	3,771	0.00
	Office Type C	110.9	gm/office	56	6,212	0.01
	Office TypeD	613.8	gm/office	4	2,455	0.00
	Office Type E	420.1	gm/office	6	2,521	0.00
3.0	**Street**	**210.0**	**gm/meter**	**20,000**	**4,200,000**	**4.20**
4.0	**Waste from nearest VDCs**					
Total						**11.7**

CHAPTER 2 CONCLUSION

2.1 Waste Unit Generation Rate

The waste generation rate of different municipalities of the Kathmandu Valley is presented in Table 2.1-1.

Table 2.1-1 Unit Generation Rate of Municipalities of the Kathmandu Valley

Municipality	KMC	LSMC	BKM	KRM	MTM
Household (gm/person/day)	245.8	267.7	117.9	148.5	165.4
Commercial (gm/unit/day)					
- Hotel and Rest	3128.80	2082.66	3319.41	3561.57	2410.57
- Market	460.28	1005.00	1089.18	2354.29	808.14
- Office	161.77	749.16	966.57	528.29	603.18
Street (gm/m)	210.9	209.8	51.3		

2.2 Waste Quality Composition

Table 2.2-1 presents the waste quality composition of the five municipalities of the Kathmandu Valley.

Table 2.2-1 Composition of Waste

	KMC			LSMC			BKM		KRM		MTM	
	1	2	3	1	2	3	1	2	1	2	1	2
Garbage	70.9	69.4	59.3	78.8	78.6	40.7	87.0	86.9	80.2	80.2	84.9	84.8
Paper	10.1	9.6	17.3	9.0	8.5	32.4	3.3	3.4	5.5	5.7	6.5	6.6
Textile	1.9	2.2	0.0	0.9	1.0	7.1	0.9	0.8	1.3	1.5	0.8	0.7
Wood	3.5	3.9	4.9	2.0	2.4	2.3	1.0	1.2	2.5	2.2	1.3	1.5
Plastic	6.7	6.9	10.8	7.0	6.9	10.8	3.3	3.4	6.1	6.2	5.5	5.5
Leather	0.0	0.0	0.0	0.1	0.2	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Metal	0.6	0.6	0.8	0.3	0.3	0.5	0.3	0.3	0.6	0.4	0.4	0.3
Glass	4.9	5.5	1.5	1.0	0.9	0.6	2.1	1.6	2.7	3.5	0.2	0.3
Ceramic	0.1	0.1	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Others	1.4	1.8	3.2	0.6	0.7	4.4	2.1	2.5	1.1	0.9	0.4	0.3

Note: 1. Household Waste, 2. Commercial Waste, 3. Street Waste

2.3 Moisture Content of Waste

The moisture content of waste of the municipalities were tested through quality test. The result of the survey is presented in following Table 2.3-1.

Table 2.3-1 Moisture Content of Waste of the Kathmandu Valley

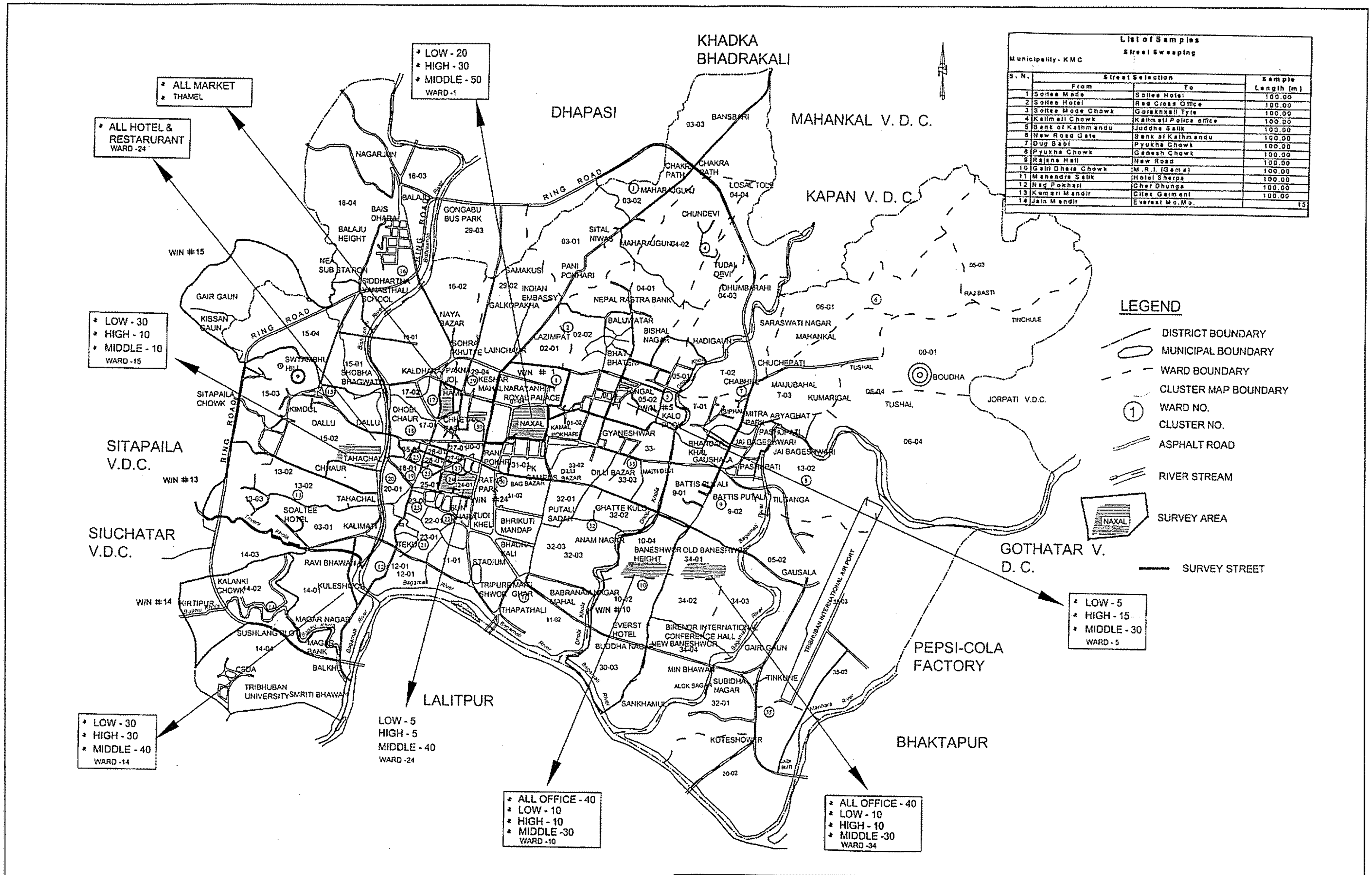
Municipality	KMC	LSMC	BKM	KRM	MTM
Household (gm/person/day)	64.7	66.0	63.4	68.1	60.6
Commercial (gm/unit/day)					
- Hotel and Rest	58.5	67.2	67.8	68.6	69.0
- Market	12.3	32.9	56.7	54.7	49.9
- Office	39.4	17.3	44.3	31.6	48.4
Street (gm/m)	39.4	62.65			

2.4 Bulk Density of Waste of the Kathmandu Valley

The bulk density of waste of the municipalities were tested through quality test. The result of the survey is presented in following Table 2.4-1.

Table 2.4-1 Bulk Density of Municipalities of the the Kathmandu Valley

Municipality	KMC	LSMC	BKM	KRM	MTM
Household (gm/person/day)	182.9	197.4	139.9	183.4	195.9
Commercial (gm/unit/day)					
- Hotel and Rest	282.48	161.86	210.92	210.92	198.11
- Market	95.53	131.62	160.35	160.35	99.24
- Office	50.12	83.45	116.73	116.73	71.47



List of Samples

Street Sweeping

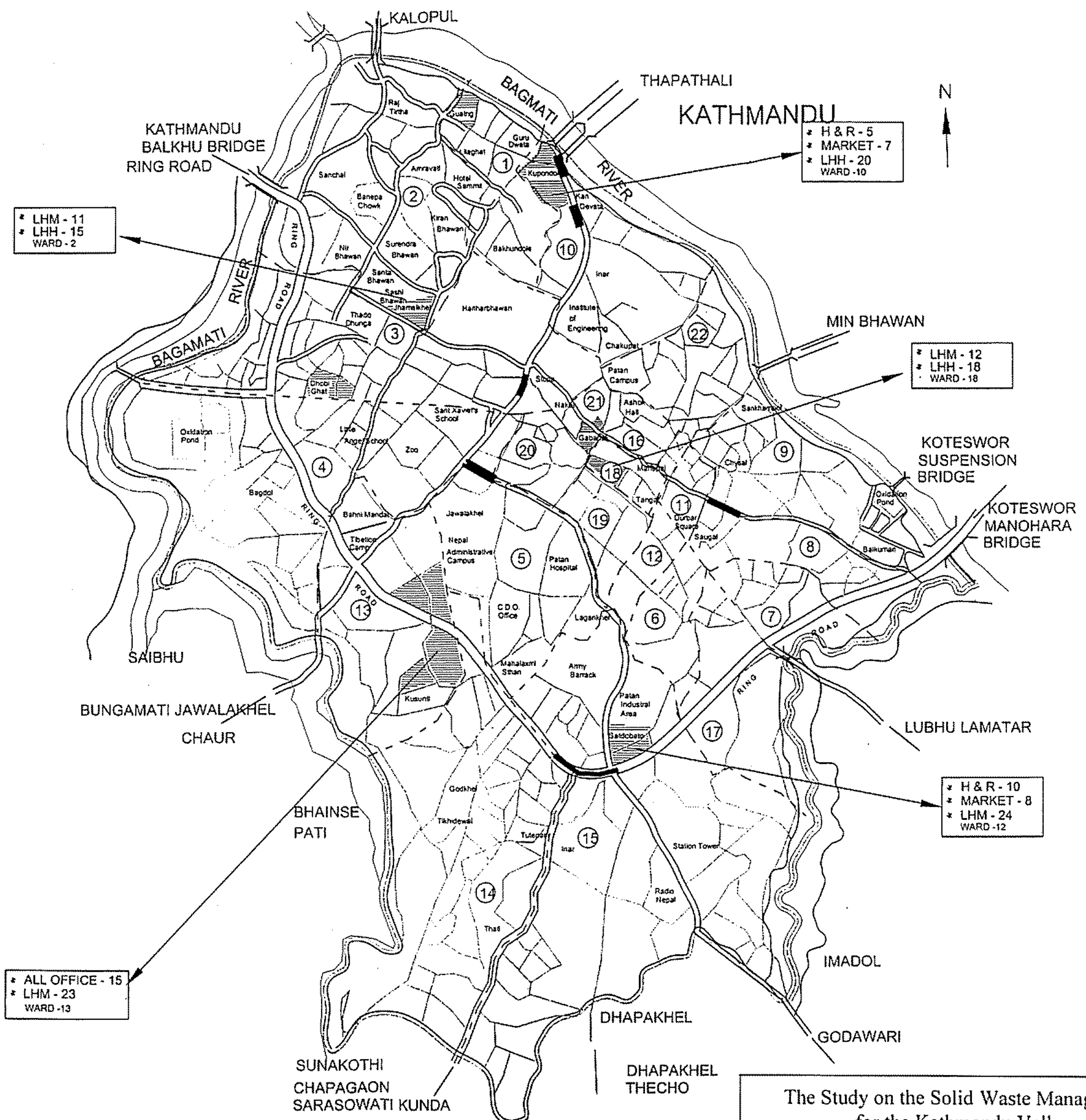
Municipality - KMC

S. N.	Street Selection: From	Street Selection: To	Sample Length (m)
1	Soltee Mode	Soltee Hotel	100.00
2	Soltee Hotel	Red Cross Office	100.00
3	Soltee Mode Chowk	Gorakhkali Tyre	100.00
4	Kalimati Chowk	Kalimati Police office	100.00
5	Bank of Kathmandu	Juddha Salik	100.00
6	New Road Gate	Bank of Kathmandu	100.00
7	Dug Babi	Pyukha Chowk	100.00
8	Pyukha Chowk	Ganesh Chowk	100.00
9	Rajana Hall	New Road	100.00
10	Gaiti Dhara Chowk	M.R.I. (Gama)	100.00
11	Mahendra Salik	Hotel Sherpa	100.00
12	Nag Pokhari	Char Dhunga	100.00
13	Kumari Mandir	Citez Garment	100.00
14	Jain Mandir	Everest Mo.Mo.	15

The Study on the Solid Waste Management for the Kathmandu Valley

Japan International Cooperation Agency

Figure 1.1
Sampling Location of Quantity Survey in KMC



Municipality- Lalitpur

S.No	Street Selection		Length of Street
	From	To	
1	Hanuman Than	Kan Devata	100
2	Kan Devata	Hotel Himalayan	100
3	Pulchock	St. Xaviers Schoo	100
4	Jawalakhel	Everest Postal	100
5	Mangal Bazzar	Mabapal Chock	100

LEGEND;

- MUNICIPALITY BOUNDARY
- WARD BOUNDARY
- WARD NO.
- ARANIKO HIGHWAY
- TRACK ROAD
- ASPHALTED ROAD
- STREAM
- POKHARI (POND)
- SURVEY AREA
- SURVEY STREET

The Study on the Solid Waste Management for the Kathmandu Valley

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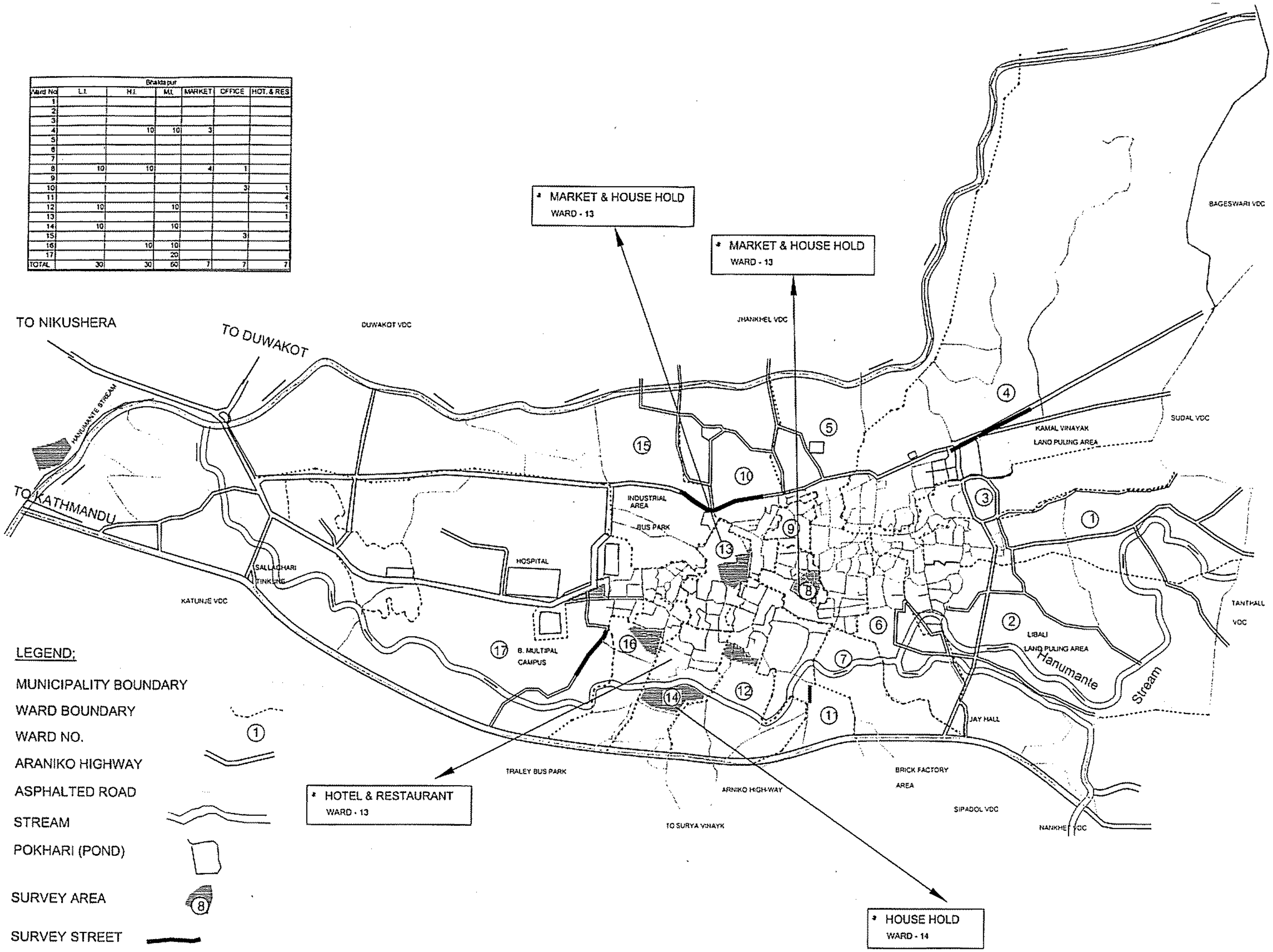
Figure 1.2
Sampling Location of Quantity Survey in LSMC

Bhaktapur						
Ward No	L.I.	H.I.	M.I.	MARKET	OFFICE	HOT. & RES
1						
2						
3						
4		10	10	3		
5						
6						
7						
8	10	10		4	1	
9						
10					3	1
11						4
12	10		10			1
13						1
14	10		10			
15					3	
16		10	10			
17			20			
TOTAL	30	30	60	7	7	7



The Study on the Solid Waste Management for the Kathmandu Valley

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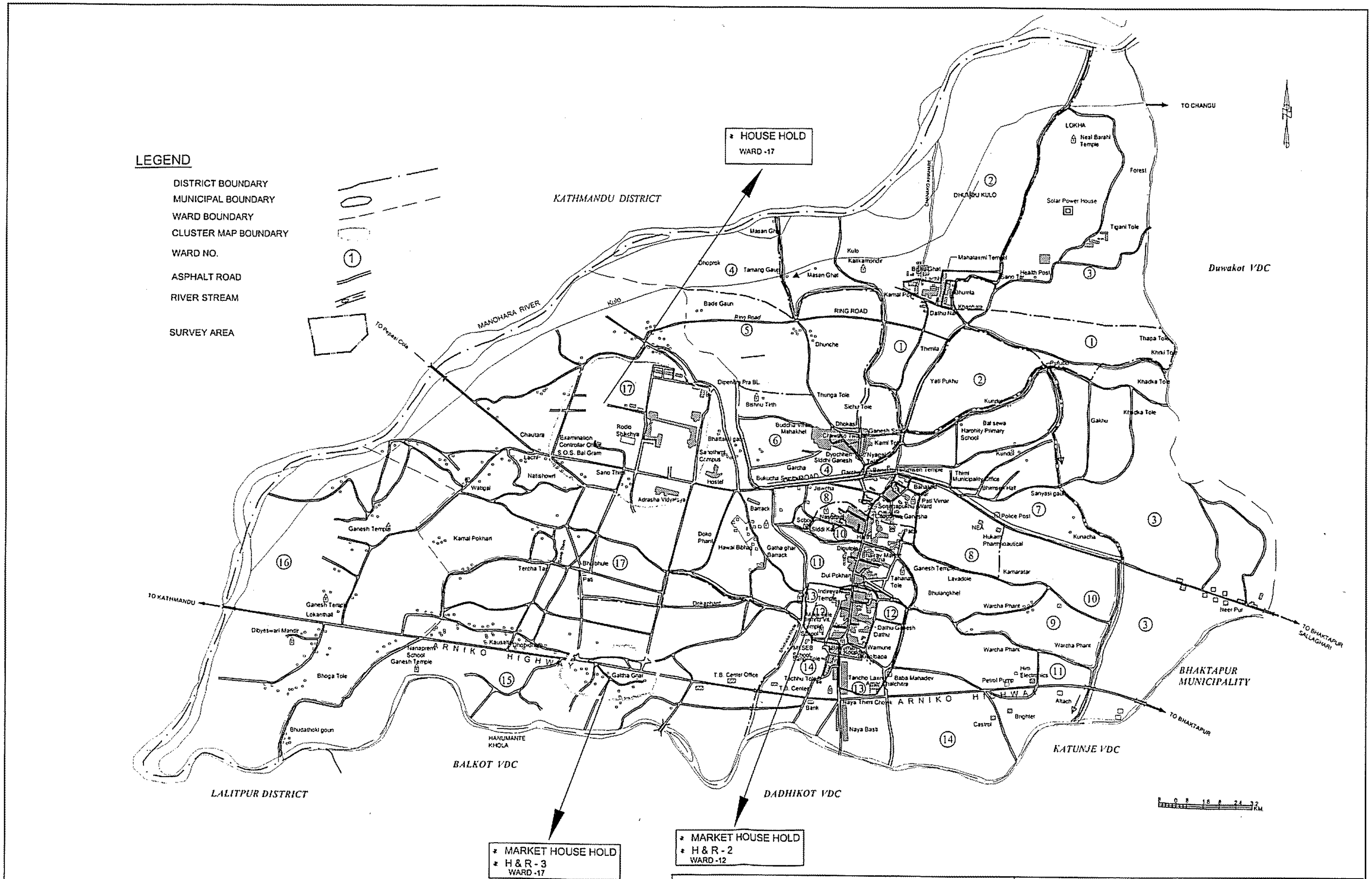
Figure 1.3
Sampling Location of Quantity Survey in BKM



The Study on the Solid Waste Management for the Kathmandu Valley

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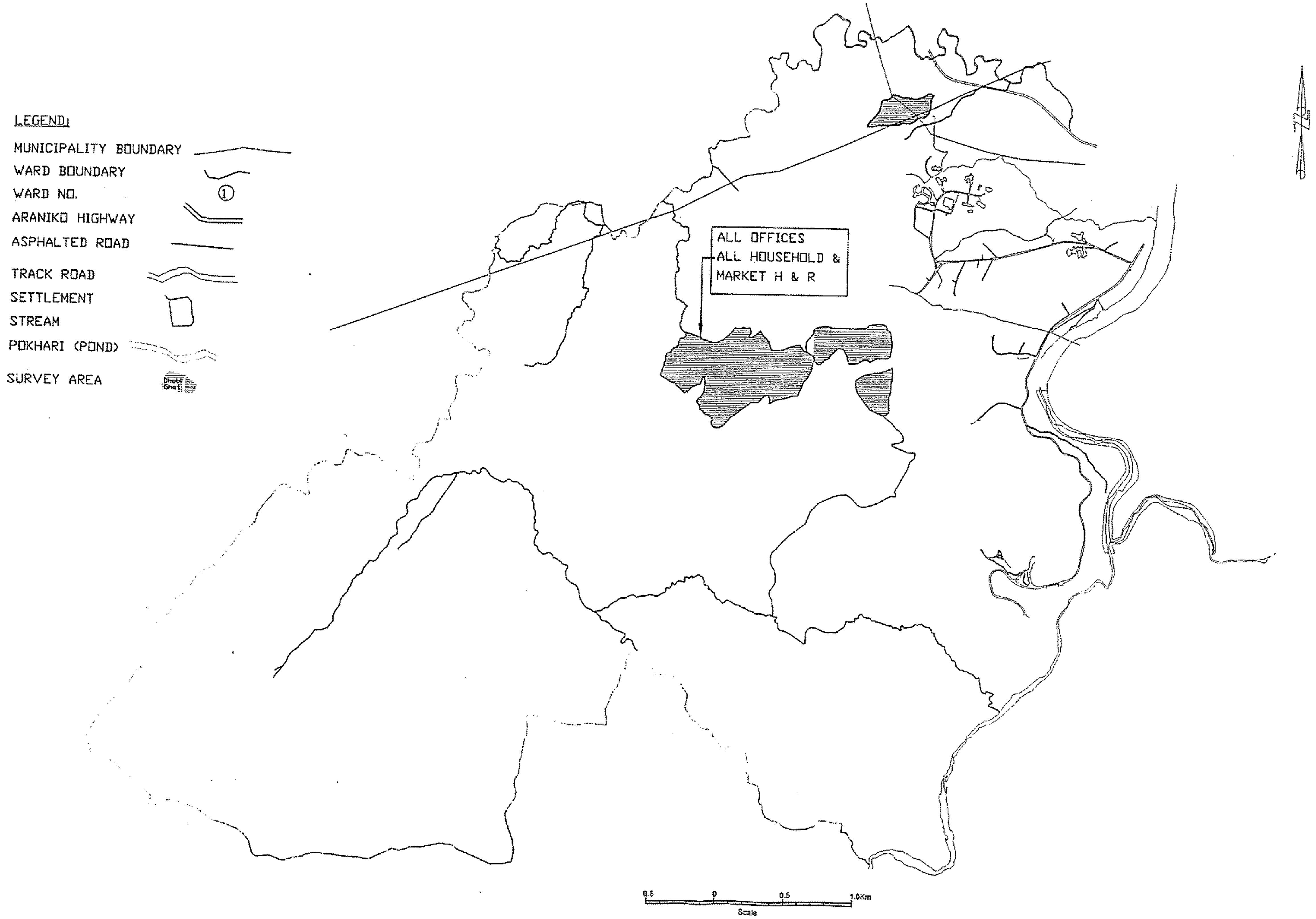
Figure 1.4
Sampling Location of Quantity Survey in MTM



The Study on the Solid Waste Management for the Kathmandu Valley	**Figure 1.5**
Japan International Cooperation Agency	**Sampling Location of Quantity Survey in KRM**

Pilot Project E-2

Result of Solid Waste Quantity and Quality Survey (II)

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CHAPTER 1 SOLID WASTE QUANTITY SURVEY WITH AND WITHOUT COMPOST BINS

1.1 Quantity Survey at KMC

Quantity survey for the three municipalities was carried out for a period of 8 days starting from June 8th 2005, Wednesday. Through out the period the weather was sunny to partly cloudy. The survey was carried out at areas of Ward 21, KMC.

There were 15 households (HHs) provided with CKV compost bins. Average per capita generation organic waste was 11.27 gm person per day and that of inorganic waste was 21.64 gm per person per day. In total the average was 32.91 gm per person per day.

Similarly there were 15 households that were selected near to the houses with CKV compost bin. Average per capita generation of organic waste was 96.49 gm per person per day and that of inorganic waste was 34.25 gm per person per day. In total the average per capita generation was 130.74 gm per person per day.

Comparing average per capita (organic, inorganic and total) for the two cases, are shown in Table 1.1-1, it is evident that households provided with CKV compost bin generates less waste than the houses without bins. A festival, *Sittinakh* was observed during the survey period, which was on Sunday, June 12, 2005, which could have been the reason for doubling (Refer Table 1.1-1) of organic waste amount when compared to inorganic waste amount in case of households provided with bin.

Table 1.1-1 Per Capita Comparison Between Hh With And Without Compost Bin

Day		1	2	3	4	5	6	7	avg per capita
		Thur	Fri	Sat	Sun	Mon	Tue	Wed	
With bin	org	10.30	1.65	0.37	22.50	17.87	2.56	23.66	11.27
	inorg	30.55	17.99	25.67	11.04	35.43	9.27	21.52	21.64
	total	40.85	19.63	26.04	33.54	53.29	11.83	45.18	32.91
Without bin	org	69.81	76.31	68.67	96.88	112.12	120.87	130.81	96.49
	inorg	20.82	46.97	24.79	66.92	20.97	32.07	27.22	34.25
	total	90.63	123.28	93.46	163.80	133.08	152.93	158.03	130.74

Source: JICA Study Team, Field Survey, 2005

Daily fluctuation in waste generation from households with and without compost bin is shown by Figure 1.1-1. The figure also shows that for household with bin organic waste generation is less, compared to inorganic waste generation. The scenario is totally different for the other case, i.e households without compost bin.

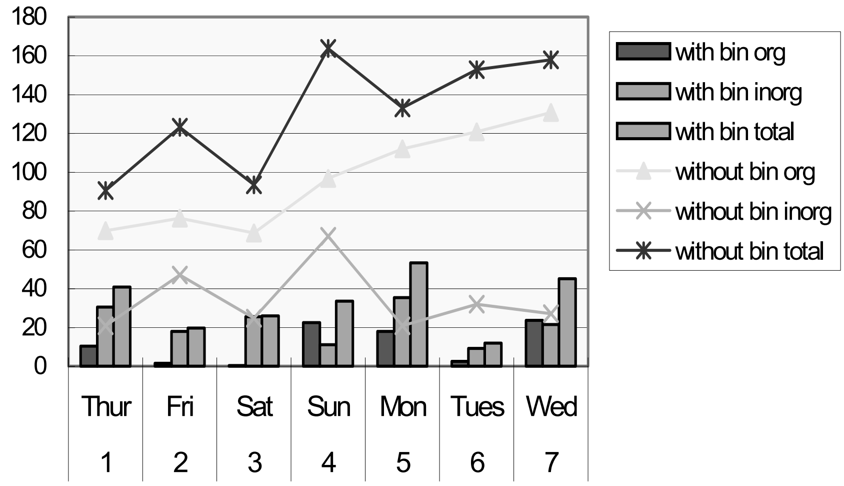


Figure 1.1-1 Daily Fluctuation of Waste Generation Between The Household With and Without Compost Bin

Source: JICA Study Team, Field Survey, 2005

1.2 Quantity Survey at LSMC

Quantity survey for LSMC was carried out on the same dates as in KMC. The sample size in LSMC was 15 households provided with CKV compost bin and 15 households near to these (without bin).

In the case of households provided with CKV compost bin, average per capita generation of organic waste was 37.53 gm person per day and that of inorganic waste was 54.51 gm per person per day. In total the average waste generation was 92.03 gm per person per day. Similarly, average per capita generation of households without CKV compost bin of organic waste was 78.56 gm person per day and that for inorganic waste was 38.15 gm per person per day. In total the average generation was 116.71 gm per person per day for the households without compost bin. Organic and total waste generated from households with bin is less compared to households without bin. However, inorganic waste generation for the households with compost bin is more than the households without compost bin. This may be because first to fourth day (Table 1.2-1) for inorganic waste in the case of LSMC is high for household with bin than that of household without bin, despite the fact that all of the 15 household with bin do segregate and sell. The inorganic portion could have contained major proportion of non-recyclables, which they ultimately had to throw.

Table 1.2-1 Per Capita Comparison Between Household With and Without Compost Bin

	Day	1	2	3	4	5	6	7	avg per
		Thur	**Fri**	**Sat**	**Sun**	**Mon**	**Tue**	**Wed**	**capita**
With bin	org	115.71	5.64	24.55	42.76	30.00	25.51	18.53	37.53
	inorg	73.59	97.88	73.97	45.58	22.82	26.47	41.22	54.51
	total	**189.29**	**103.53**	**98.53**	**88.33**	**52.82**	**51.99**	**59.74**	**92.03**
Without bin	org	93.10	79.11	64.07	63.61	69.01	115.76	65.25	78.56
	inorg	41.71	44.68	24.40	17.04	60.06	40.41	38.73	38.15
	total	**134.81**	**123.80**	**88.47**	**80.65**	**129.08**	**156.16**	**103.99**	**116.71**

Source: JICA Study Team, Field Survey, 2005

Figure 1.2-1 shows the daily fluctuation of per capita of households with and without compost bins the figure also shows that for household with bin organic waste generation is less compared to inorganic waste generation. The scenario is totally different for the other case, i.e. households without compost bin

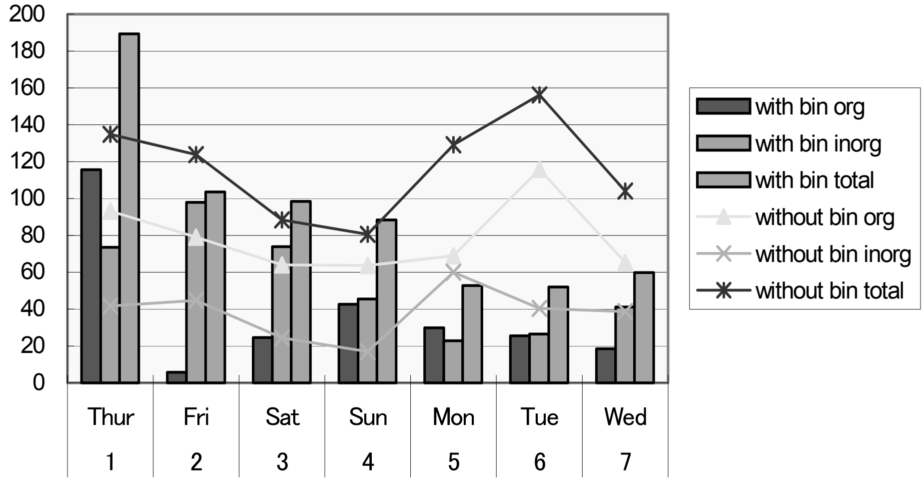


Figure 1.2-1 Comparison Between the Daily Fluctuation of Per Capita Between Households With and Without Compost Bins

Source: JICA Study Team, Field Survey, 2005

1.3 Quantity Survey at KRM

Sampling was different for Kirtipur Municipality. Three different samples were taken, 10 Households with suiro and compost bin, 10 households with compost bin and 10 households without any tools. Table 1.3-1 shows that the average per capita of organic waste , inorganic waste and total waste is 38.23 gm per person per day, 128 gm per person per day and 166.49 gm per person per day, respectively. Similarly, per capita of organic, inorganic and total waste for households with suiro is 60.34 gm per person per day, 74.82 gm per person per day and 135.17 gm per person per day, respectively. For the households without any tools the per capita is 62.20 gm per person per day, 43.79 gm per person per day and 106.00 gm per person per day, respectively.

The average per capita for inorganic waste for households with bin and suiro is minimum, followed by households with suiro and without any tools.

Table 1.3-1 data also reveals that first 2 days inorganic generation is high for household with bin and suiro. This was because people were bringing out the inorganic waste that was accumulated in their houses since long. 60% of these households do not receive waste management service neither from municipality nor from private sector. Hence the waste was accumulated for few days was also collected during first two days f the survey.

Table 1.3-1 Per Capita Comparison Between Households With and Without Tools

Day		1 Thur	2 Fri	3 Sat	4 Sun	5 Mon	6 Tue	7 Wed	avg per capita
With bin and suiro	org	14.33	130.09	33.88	45.56	9.10	7.31	27.31	38.23
	inorg	304.40	276.67	73.96	57.98	73.43	34.96	76.42	128.26
	total	318.73	406.75	107.84	103.55	82.54	42.27	103.73	166.49
With suiro	org	73.31	53.47	80.09	57.87	57.20	40.11	60.34	60.34
	inorg	123.98	168.22	85.93	36.00	48.73	6.85	54.07	74.82
	total	197.29	221.69	166.02	93.87	105.93	46.96	114.41	135.17
Without bin and suiro	org	78.62	22.57	54.93	127.92	48.88	62.17	40.33	62.20
	inorg	38.68	18.75	54.21	74.72	28.75	60.92	30.53	43.79
	total	117.30	41.32	109.14	202.64	77.63	123.09	70.86	106.00

Source : Field Survey, 2005

From the questionnaire survey it was found that 40% households without tools provided were practice composting. Similarly in the case of the sample households provided with suiro, 80 % households were practice composting. Composting was done in compost pit. The inorganic waste collected is generally sold or burn.

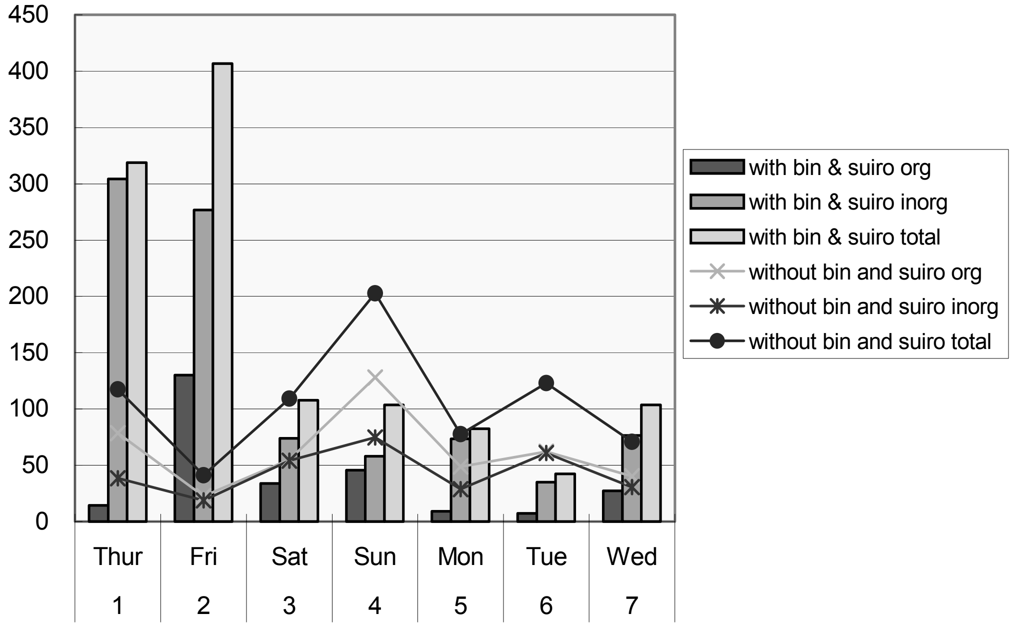


Figure 1.3-1 Daily Per Capita Fluctuation of Households With Bin and Suiro and Without Bin and Suiro

Source: JICA Study Team, Field Survey, 2005

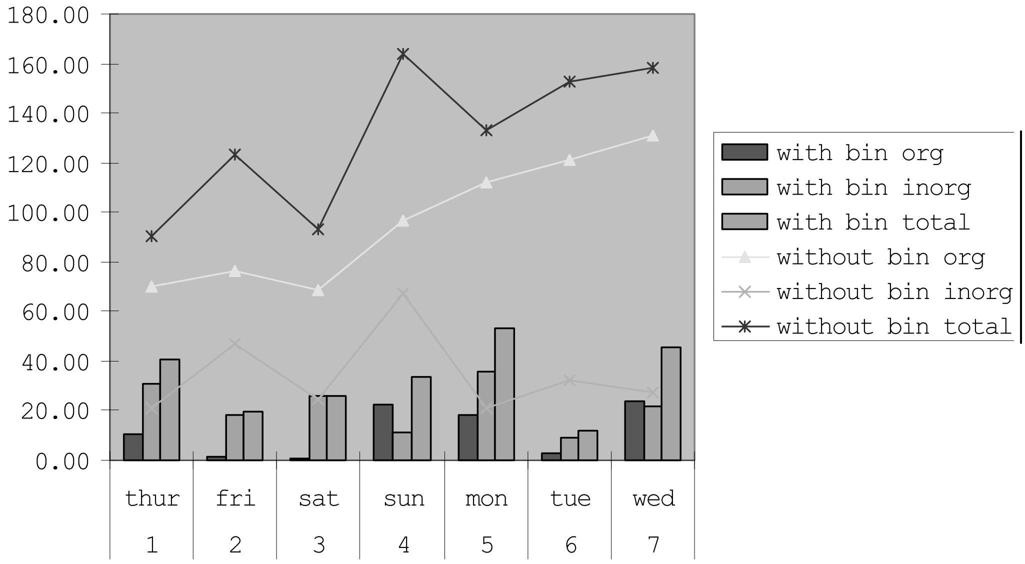


Figure 1.3-2 Daily Per Capita Fluctuation of Household With Bin

Source: JICA Study Team, Field Survey, 2005

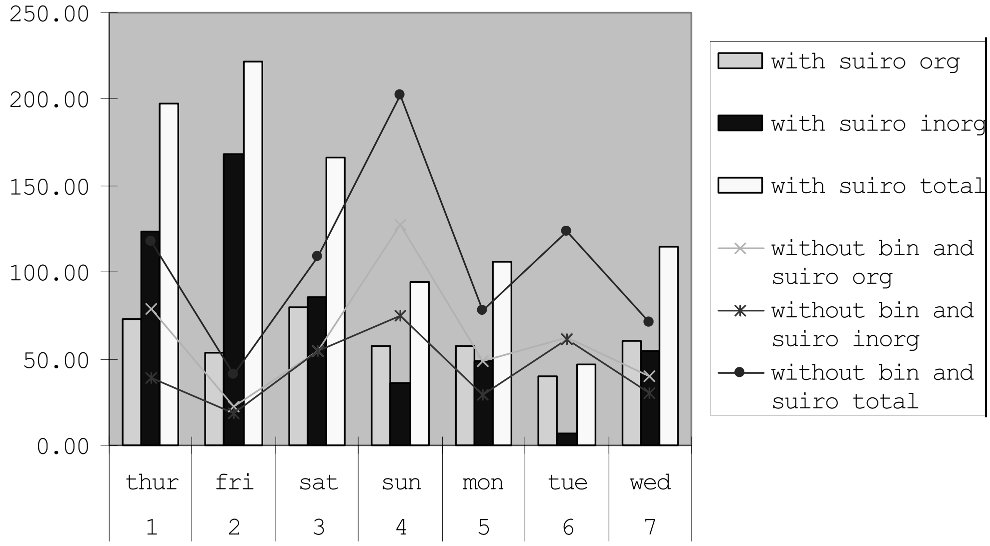


Figure 1.3-3 Daily Per Capita Fluctuation of Household s Without Suiro

Source: JICA Study Team, Field Survey, 2005

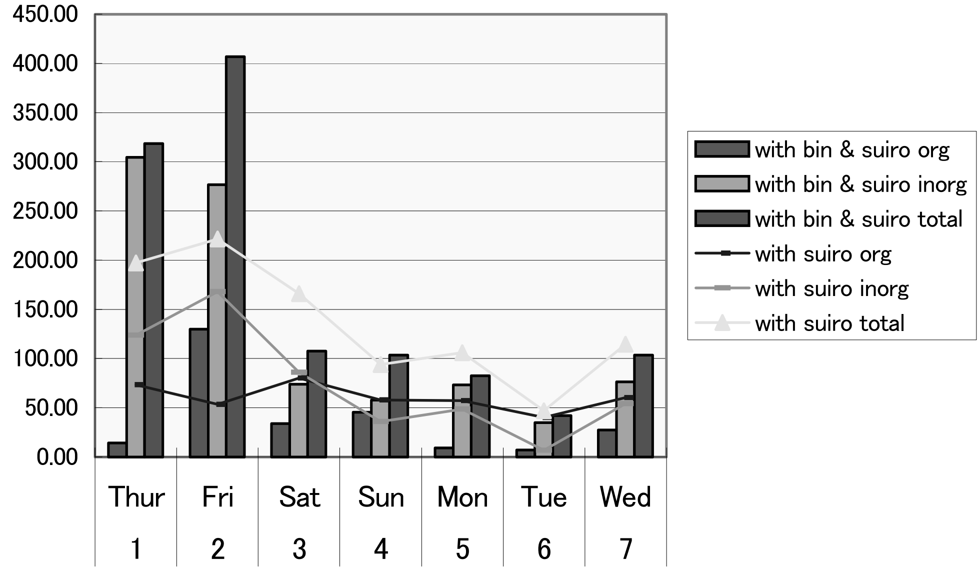


Figure 1.3-4 Daily Per Capita Fluctuation of Household With Bin and Suiro and With Suiro

Source: JICA Study Team, Field Survey, 2005

CHAPTER 2 SOLID WASTE QUALITY SURVEY WITH AND WITHOUT COMPOST BINS

2.1 Quality Survey at KMC

In KMC total 4 samples, 2 samples for HH provided with bin and 2 samples for households without compost bin were collected. Since the waste generations of 15 HH is very less, sampling was done for 2 different days; 2 samples - one with bin and without bin analyzed per day. The findings of the survey carried out during June, 2005 is given below:

Composition of solid waste generated by households in terms of percentage by weight of each composition is given below in Table 2.1-1.

Table 2.1-1 Average Composition Of Households Waste by Percentage of Weight

House hold Type	Waste Components by percentage of weight									
	Garbage	Paper	Textile	Wood	Plastic	Rubber/ Leather	Metal	Glass	Ceramics	Others
With bin	56.77	5.61	2.14	0.53	30.21	1.28	0.31	2.14	0.59	4.40
Without bin	78.76	4.55	1.77	0.14	7.54	0.21	0.37	5.17	1.31	0.17

Source: JICA Study Team, Field Survey, June 2005

From the above table the effectiveness of compost bin is evident. The amount of garbage is higher, 78.76 % for the households without compost bin when compared to households with compost bin 56.77 %.

Average waste composition of households with and without bin in terms of percentage by weight is given in Figure 2.1-1 and Figure 2.1-2 respectively.

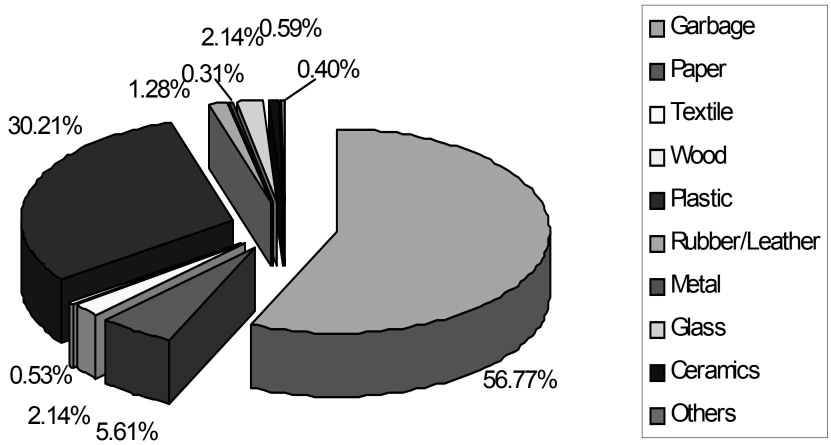


Figure 2.1-1 Average Waste Composition of Households With Bin in terms of Percentage by Weight

Source: JICA Study Team, Field Survey, June 2005

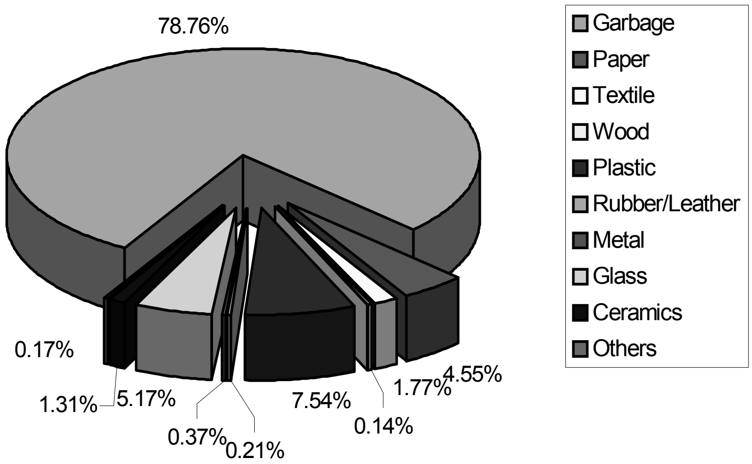


Figure 2.1-2 Average Waste Composition of Households Without Bin in terms of Percentage by Weight

Source: JICA Study Team, Field Survey, June 2005

Moisture content of each components of household solid waste is given below in Table 2.1-2.

Table 2.1-2 Moisture Content Of Household Waste

House hold Type	Moisture Content of each component of solid waste in percentage									
	Garbage	Paper	Textile	Wood/ Leave	Plastic	Rubber/ Leather	Metal	Glass	Ceramics	Others
With bin	49.68	23.32	15.97	-	34.56	-	-	-	-	-
with out bin	63.61	19.13	26.05	-	13.91	-	-	-	-	-

Source: JICA Study Team, Field Survey, June 2005

2.2 Quality Survey at LSMC

In LSMC, total 4 samples, 2 for households with bin and 2 for households without bin were analyzed. Since the waste generations of 15 HH is very less, sampling was done for 2 different days; 2 samples - one with bin and without bin analyzed per day. The findings of the survey carried out during June, 2005 are given below:

Composition of solid waste generated by households in terms of percentage by weight of each composition is given in Table 2.2-1.

Table 2.2-1 Average Composition of Households Waste By Percentage of Weight

House hold Type	Waste Components by percentage of weight									
	Garbage	Paper	Textile	Wood/ Leave	Plastic	Rubber/ Leather	Metal	Glass	Ceramics	Others
with bin	68.52	9.60	1.70	0.34	5.91	0.51	0.30	1.10	10.28	1.74
without bin	76.44	4.70	3.05	0.44	8.17	0.83	1.14	2.22	2.73	0.25

Source: JICA Study Team, Field Survey, June 2005

From the above table it is evident that amount of garbage is slightly higher, 76.44% for the households without compost bin when compared to households that uses compost bin 68.52%.

Average waste composition of houses with bin and without bin in terms of percentage by weight is given in Figure 2.2-1 and Figure 2.2-2 respectively.

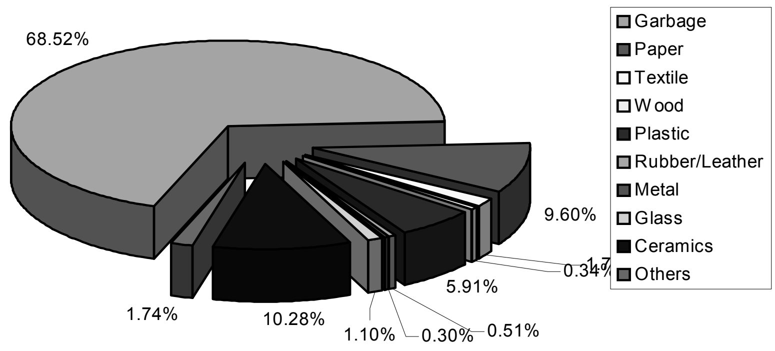


Figure 2.2-1 Average Waste Composition of Households With Bin in terms of Percentage by Weight

Source: JICA Study Team, Field Survey, June 2005

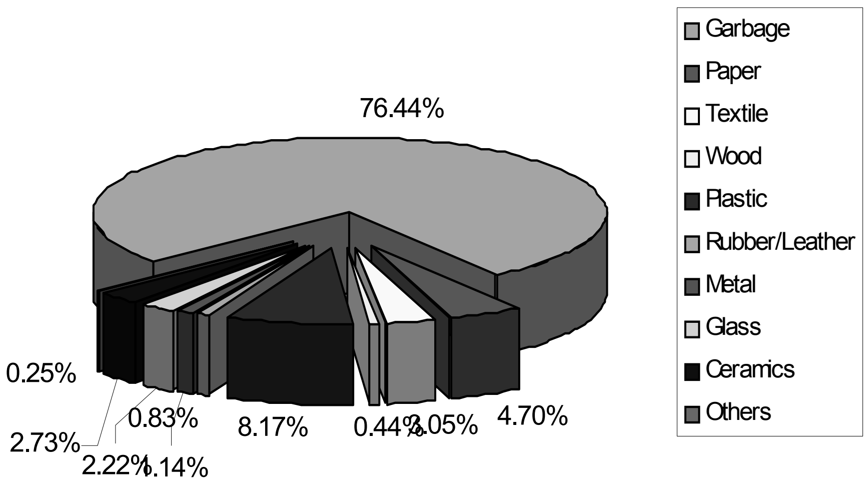


Figure 2.2-2 Average Waste Composition of Households Without Bin in terms of Percentage by Weight

Source: JICA Study Team, Field Survey, June 2005

Moisture content of each components of household solid waste is given in Table 2.2-2

Table 2.2-2 Moisture content of household waste

House hold Type	Moisture Content of each component of solid waste in percentage									
	Garbage	Paper	Textile	Wood/ Leave	Plastic	Rubber/ Leather	Metal	Glass	Ceramics	Others
With bin	58.79	16.67	7.88	-	23.24	-	-	-	-	-
Without bin	60.07	13.48	8.60	-	18.29	-	-	-	-	-

Source: JICA Study Team, Field Survey, June 2005

2.3 Quality Survey at KRM

In KRM, total 6 samples, 2 for households with bin and suiro, 2 for households with suiro and 2 for households without any tools were surveyed. The findings of the survey carried out during June, 2005 are given below.

Composition of solid waste generated by households with bin and suiro, with suiro and without any tools in terms of percentage by weight of each composition is given in Table 2.3-1.

Table 2.3-1 Composition of Households Waste By Percentage of Weight

House hold Type	Waste Components by percentage of weight									
	Garbage	Paper	Textile	Wood	Plastic	Rubber/ Leather	Metal	Glass	Ceramics	Others
With bin and suiro	26.10	10.38	16.41	1.45	9.29	4.44	8.65	10.99	10.51	1.78
With suiro	63.59	3.93	2.38	1.44	10.66	-	20.2	12.39	3.60	-
Without bin and suiro	83.61	6.37	3.08	-	5.20	0.14	0.35	0.20	0.94	-

Source: JICA Study Team, Field Survey, June 2005

Table 2.3-1 shows that garbage composition is highest for households without tools, which is 83.61%, followed by households with suiro 63.59% and by households with bin and suiro 26.10%. The figure clearly depicts that compost bin is an effective tool for managing organic waste/garbage.

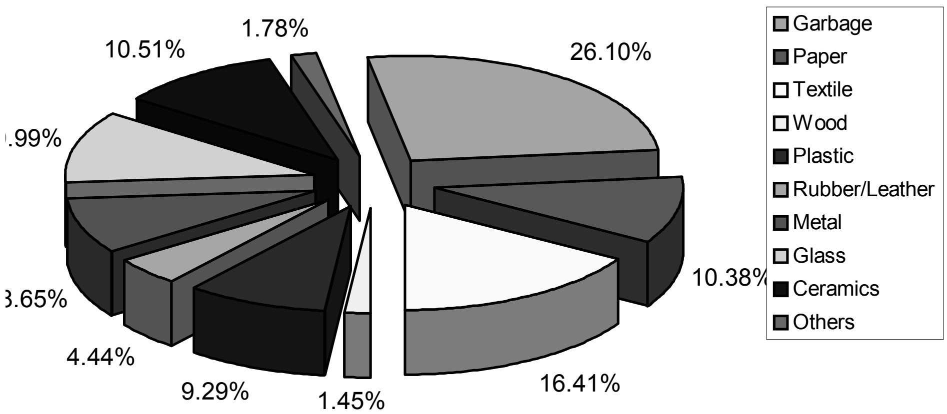


Figure 2.3-1 Average Composition of Households With Bin and Suiro in terms of Percentage by Weight

Source: JICA Study Team, Field Survey, June 2005

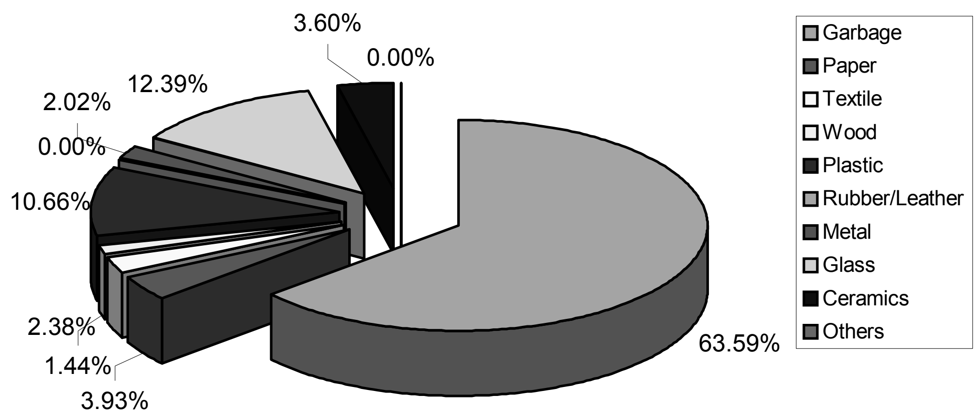


Fig. 2.3-2 Average Composition of Households With Suiro in Terms of Percentage By Weight

Source: JICA Study Team, Field Survey, June 2005

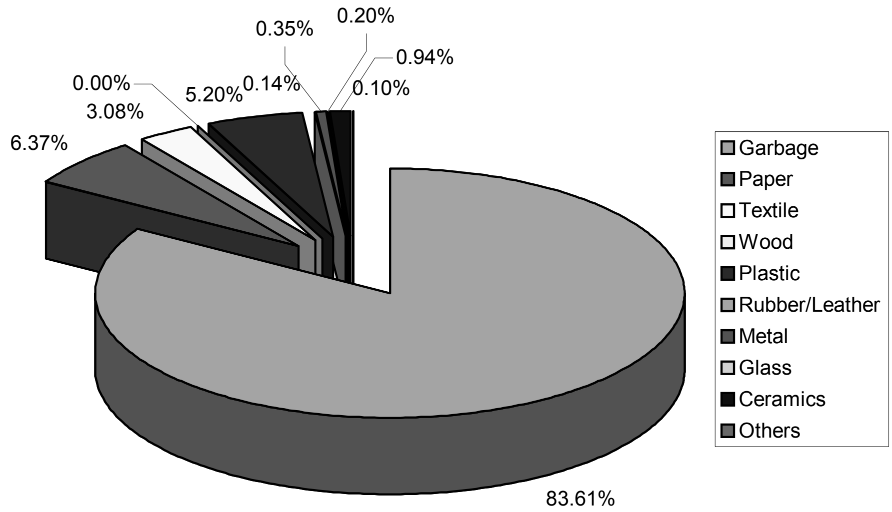


Fig. 2.3-3 Average Waste Composition of Households Without Bin and Suiro in terms of Percentage By Weight

Source: JICA Study Team, Field Survey, June 2005

The moisture content of each sample of solid waste component was measured. The result is given in the Table 2.3-2.

Table 2.3-2 Moisture Content of Household Waste

Type	Moisture Content of each component of solid waste in percentage									
	Garbage	Paper	Textile	Wood	Plastic	Rubber/ Leather	Metal	Glass	Ceramics	Others
With bin and suiro	44.07	12.56	25.38	-	10.87	-	-	-	-	-
With suiro	56.45	22.11	29.57	-	13.02	-	-	-	-	-
Without bin and suiro	56.82	27.73	35.27	-	27.44	-	-	-	-	-

Source: JICA Study Team, Field Survey, June 2005

CHAPTER 3 SOLID WASTE QUANTITY SURVEY

3.1 Bagmati River Dumping Site

The survey was carried out in the Bagmati River dumping site at Balkhu to determine the daily quantity of waste disposed at this site. Axial weighing machine was placed at Balkhu from May 22, 2005 and May 28, 2005. The waste from KMC, LSMC and KRM were disposed at this site. The findings are given below in Table 3.1-1.

Table 3.1-1 Quantity of Solid Waste Disposal at Bagmati Disposal Site

S.No	Date	KMC			KMC (P)			KMC	LMC			KRM	TOTAL
		Truck	Tractor	Total	Truck	Tractor	Total	Total	Truck	Tractor	Total	Total	
1	22-05	214540	0	350590	135250	800	307600	350590	67550	0	55650	5300	423440
2	23-05	135450	0	249750	112900	1400	295050	249750	55650	0	62600	2200	307600
3	24-05	136350	0	230900	93350	1200	391450	230900	59700	2900	76200	1550	295050
4	25-05	206050	0	312600	105700	850	366900	312600	71500	4700	66600	2650	391450
5	26-05	180550	0	297950	116000	1400	374550	297950	61950	4650	68250	2350	366900
6	27-05	185550	0	304900	117800	1550	268150	304900	65700	2550	60600	1400	374550
7	28-05	136050	0	207550	71200	300	71500	207550	57300	3300	67550	0	268150
												GRAND TOTAL	**2427140**
												AVERAGE	**346734.29**

Source: JICA Study Team, Field Survey, June 2005

Average incoming waste to the Bagmai River dumping site is 346,734 kg/day. The variation of incoming solid waste in Kg observed at the Bagmati River dumping site is shown in Figure 3.1-1.

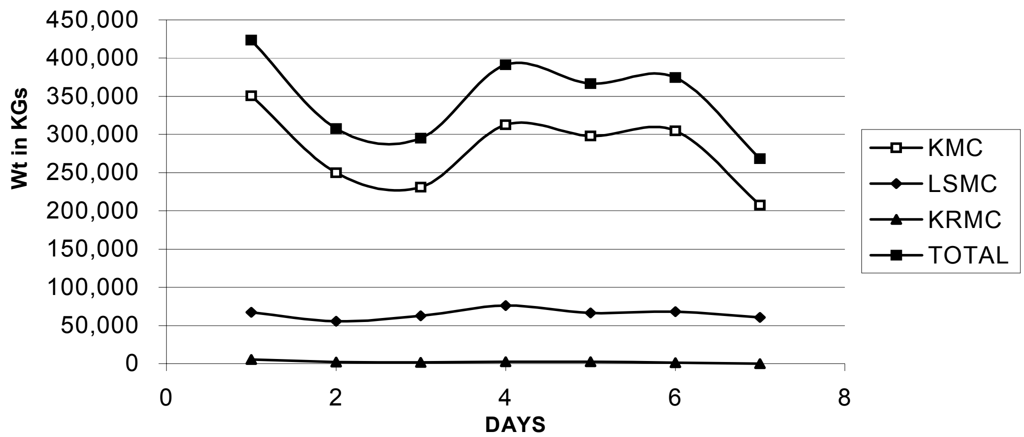


Figure 3.1-1 Incoming Waste Variation Observed at Bagmati River Dumping Site

Source: JICA Study Team, Field Survey, June 2005

The average waste generated from vegetable market and the Soaltee hotel of KMC during the survey is 26,857 kg and 36,471 kg respectively.

3.2 Teku Transfer Station

The survey was carried out to measure the incoming waste to Teku Transfer Station (T/S) by the weighing scale. The record provided by KMC has been used in the survey. Three days, Thursday, Saturday and Tuesday were selected. The findings are given below in Table 3.2-1.

Table 3.2-1 Waste Quantity Survey at Teku Transfer Station

S.N.	Date	Day	KMC			KMC (P)			Grand Total
			Truck	Tractor	Total	Truck	Tricycle	Total	
1	30-Jun	Thursday	7	67	74	24	12	36	110
2	2-Jul	Saturday	1	66	67	24	14	38	105
3	5-Jul	Tuesday	72	4	76	23	20	43	119
							GRAND TOTAL		**334**
							AVERAGE		**111.33**

Source: JICA Study Team, Field Survey, June 2005

Average incoming waste to Teku T/S is 111.3 ton. The variation of total incoming solid waste in ton observed at Teku T/S for three referred days is shown in Figure 3.2-1.

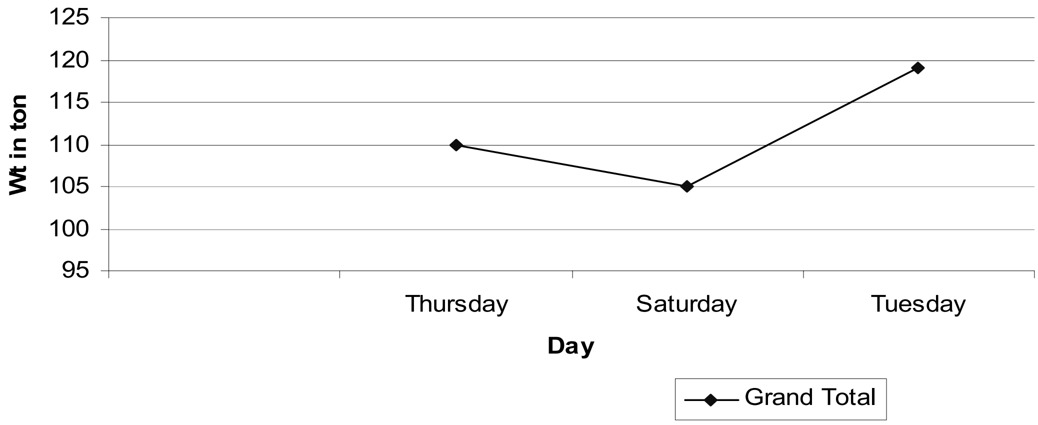


Figure 3.2-1 Incoming Waste Variation Observed at Teku Transfer Station

Source: Solid Waste Management Section, KMC.30th June-4th July 2005.

From data obtained from Solid Waste Management Section, KMC the total waste coming from Ward 21of KMC measured for 6 days (July 6-July 11, 2005) is 20,788 kg, the average weight being 3,464.67 kg.

Pilot Project E-3

User Manual for Solid Waste Database Management System

Table of Contents

1. Introduction

1.1 Overview

The Solid Waste Database Management System (SWDMS) is a simplified and user-friendly database developed in Microsoft Access. The application of SWDMS is also developed in same platform because of the voluminous and regular data to be maintained as per the need of municipalities of the Kathmandu Valley.

1.2 Modules and Functionalities

Modules and functionalities of Application

Based upon the analysis of comments and suggestion from the municipalities, SWDMS has been developed as simplified system with following five major modules.

1. ***Connection***- this is the module having single functionality for Log In and Log Out from the system which is very necessary to protect the database unauthorized data access and entry.

2. ***Setup*** – this module is used is to setup the information for the master table about on employee, route, designation, vehicle, vehicle type, users and right to users.

3. ***Entry***- this data entry module is for collecting information at landfill site, transfer station, and transfer station to landfill site. There is an option for data entry for site having automatic weighing machine or not.

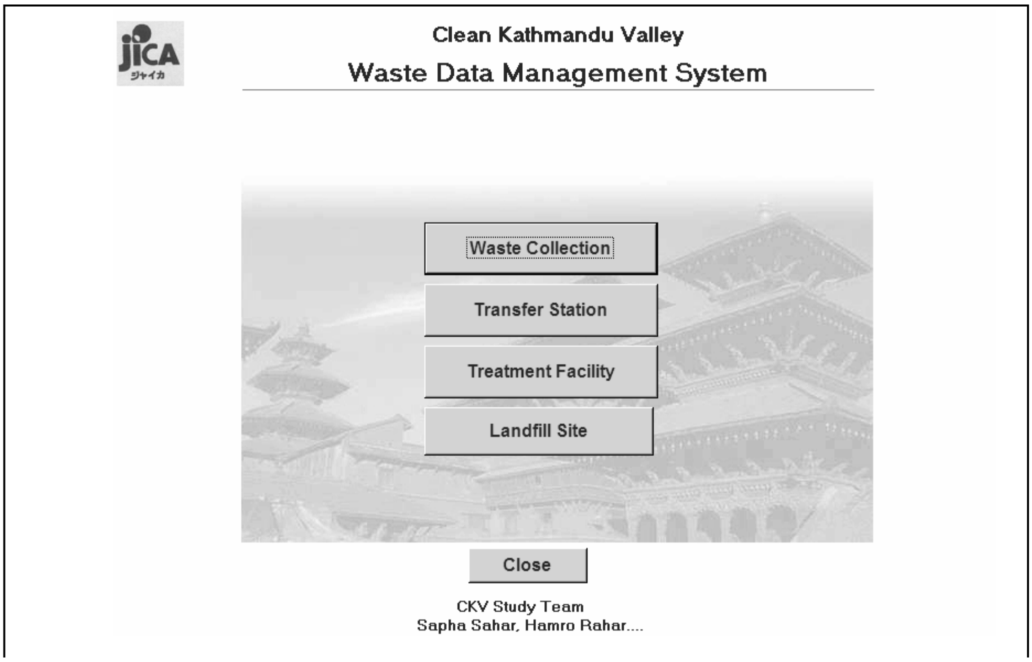
4. ***Compost Plant***- the module is specifically designed for BKM, having functionalities for data entries and production of reports on equipment entry, waste inflow, compost sales, compost recycle sales and expenses. This module can also be utilized by other municipalities once the waste processing facility is established.

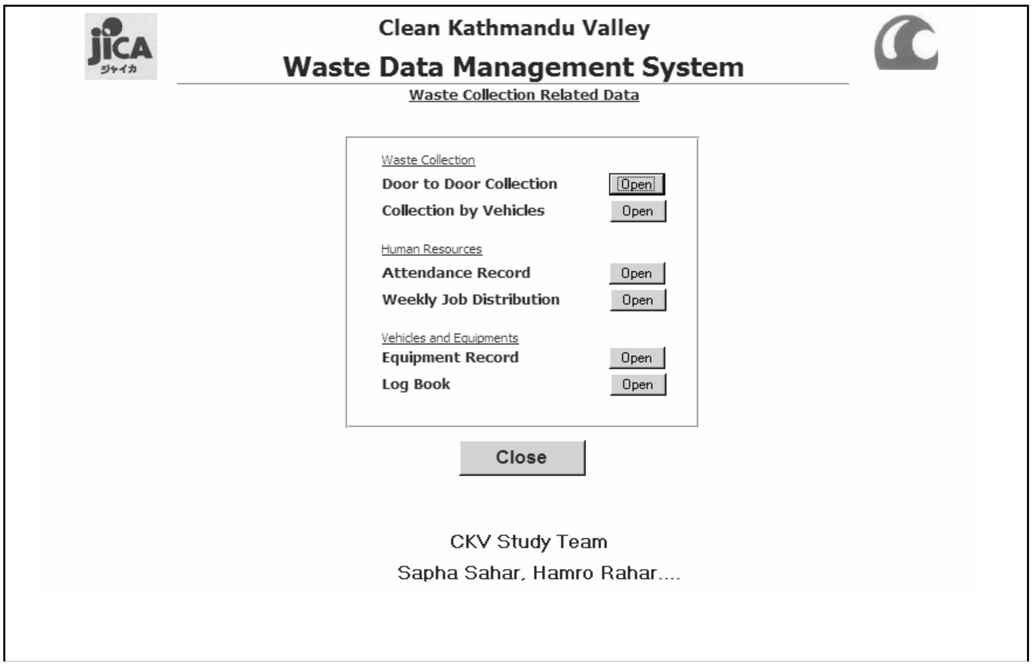
5. ***Report***- this module is to print out the report base upon the data entry. The report can be generated based on querying by date, vehicle id, vehicle type and can be prepare in the form of summary and detail reports.

1.3 Switchboard

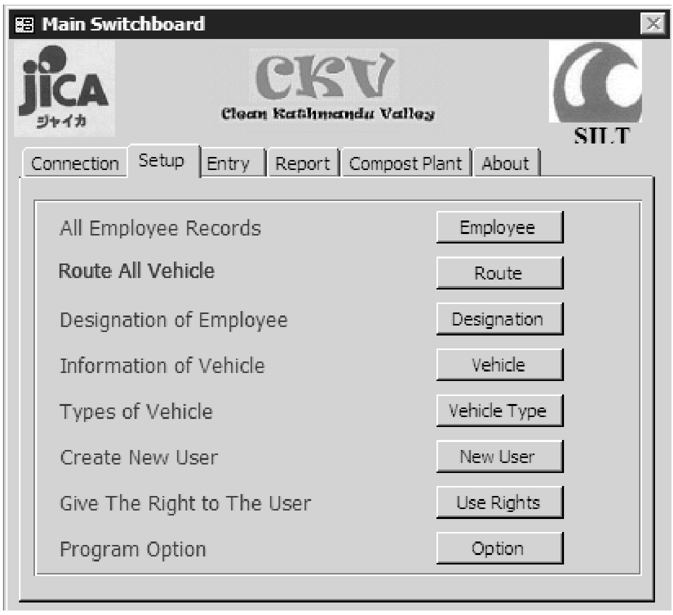
For the switchboard, a tab system visualizing all the database components in single interface are used as shown below so that user can find the them quickly and easily.

SWDMS Switchboard



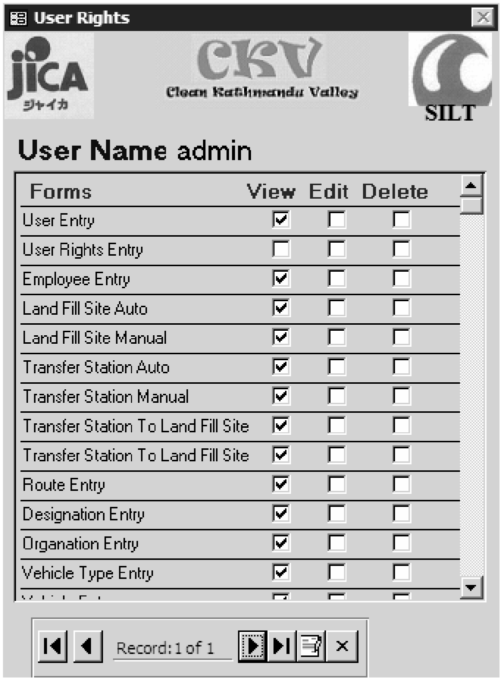


SWDMS Switchboard



SWDMS has introduced application security system. Only the permitted user can add, view, edit or delete records in the components of database and provide the right access to the specific form to the Specific users only so that databases is protected from unauthorized user.

Only specific data necessary for SWM are to be collected and entered/updated into SWDMS. Only data on waste collection at Land Fill Site, Transfer Station, Transfer Station to Land Fill Site, Waste Processing Facility (Compost Plant) are included.

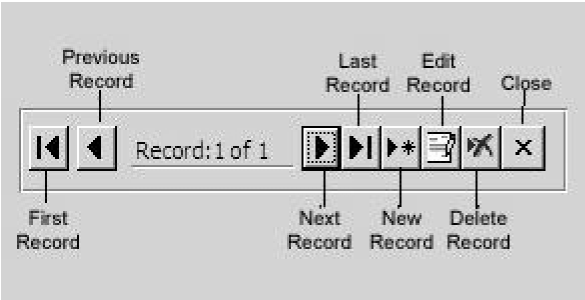


2. How to Use

Controls
Main Switchboard
Connection Tab
Setup Tab
Entry Tab
Compost Plant Tab
Reports Tab

2.1 Controls

The Controls are available which is used to navigate the record selection



First Record
This button moves your record to first record of the database.

Previous Record
This button moves the record one by one to back.

Next Record
This button moves the record one by one ahead.

Last Record
This button moves the record to the last of the database

Edit Record
From this button user can edit the exiting record. It can be accessed by only those person who do have the permission to edit. Check user rights.

Delete Record
To delete the record. Only those people can delete the records who do have the permission to delete. Check user rights.

Close
To exit from the current form.

2.2 Main Switchboard

This is the Main Board to enter into the application. It contains tab buttons which is as follows.

- Connection Tab
- Setup Tab
- Entry Tab
- Report Tab
- Composting Plant Tab
- About Tab

2.2.1 Connection Tab

This connection tab gives you the information of current log in user and option to exit from current log in.

- Log In
- Log Out

2.2.1.1 Log In

To use this application, user must enter his/her user name and password. So, every user has to create their user name and password to access the application.

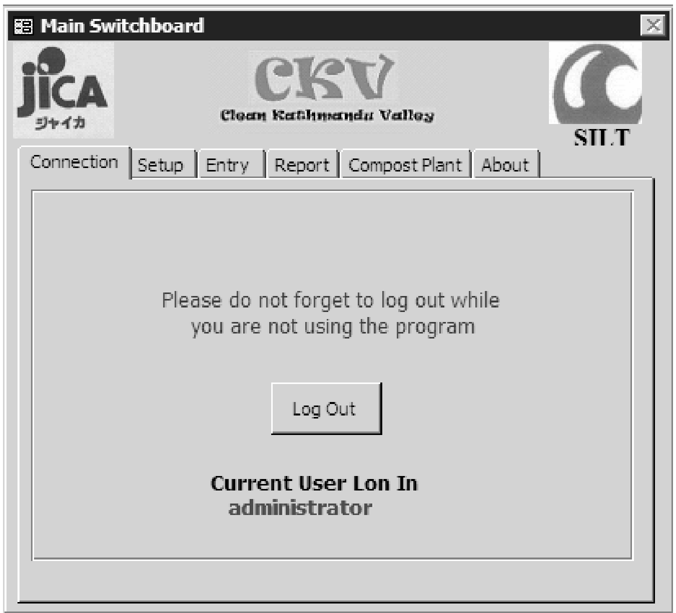
User Name-
Name of user who has given the user name and user rights to access. Without user name no one can access the application.

Password-
Password for the user

2.2.1.2 Log Out

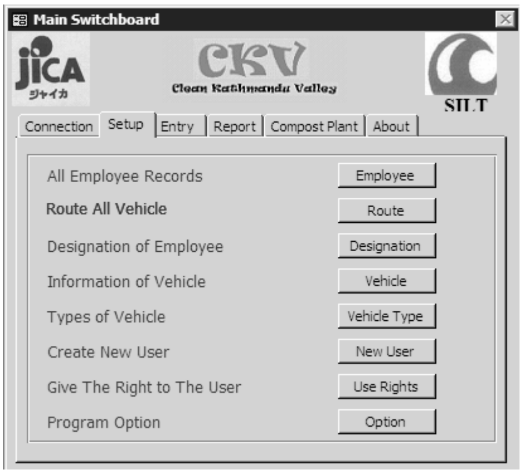
It is used to switch on to another user. Every user who has been Log In should have to Log Out from the application for data security and should not leave application without Log Out

Click on the Log Out button to switch on to another user.



2.2.2 Setup Tab

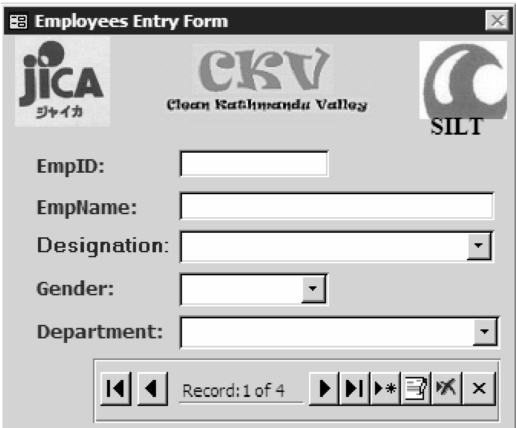
This tab is used for to maintaining the information for master form. To start data entry, user has to fill up this form relating with the other forms.



- All Employee Records
- Route of the Vehicle
- Designation of Employee
- Information of Vehicle
- Types of Vehicle
- Create New User
- Give the Rights to the User
- Program Option

2.2.2.1 Employee Entry

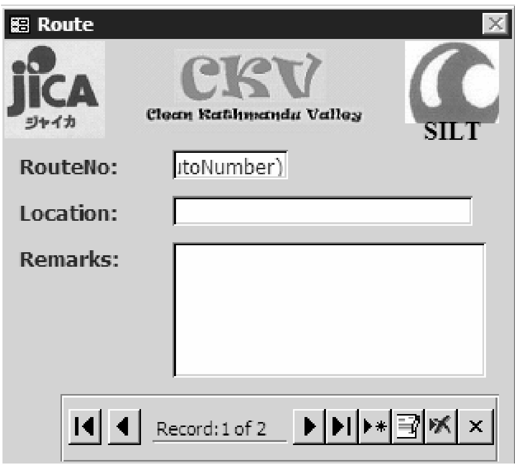
All the records of employees in the organization can be stored through this form.



Employee Name -
Full name of the employee.
Designation -
Designation of the employee
(if you want to add more designation in the box then go to **Designation Entry)**
Gender -
Gender of employee (Male or Female)
Department -
Name of the Department where employee is working

2.2.2.2 Route Entry

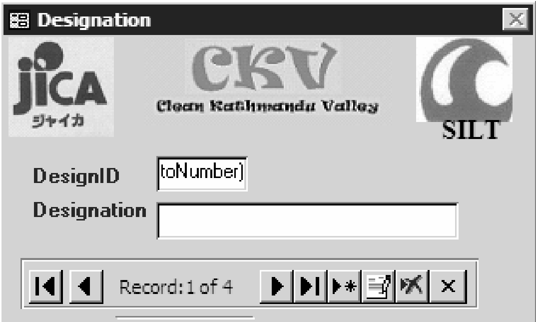
The available routes of Municipalities can be entered through this form.



Employee Name -
Full name of the employee.
Route No -
This auto number field generate route number and no need to enter.
Location –
Place name of identified route number
Remarks –
Any specific information regarding the route number

2.2.2.3 Designation Entry

The available name of designation of the employee can be entered in this form.

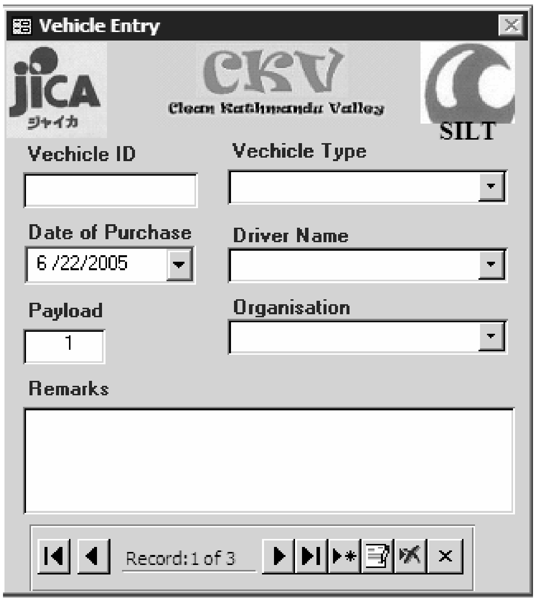


Design ID -
This auto number field is for automatic generation of Designation ID and no need to enter.

Designation –
Enter the name of designation given to employee.

2.2.2.4 Vehicle Entry

All the information related to vehicle can be entered through this form.



Vechicle ID –
Identification number of the vehicle. The number should be unique (not repeated)

Vechicle Type –
Type of the Vehicle. If the Vehicle type is not listed, click here vechicle type

Date of Purchase –
Date of purchase of vehicle.

Driver Name –
Name of driver assigned to the vehicle

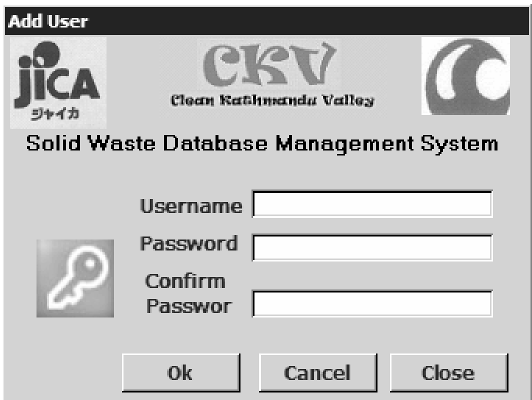
Payload –
Carrying capacity of the vehicle.

Organization –
Name of the organization who had provided the vehicle.

Remarks –
Any other remarks.

2.2.2.5 New User Entry

This function is used to assign new user's name and password to access the application. Without user name, no one can access this application. All the permission is granted to the user as per user rights. Every user must have their password and user right.



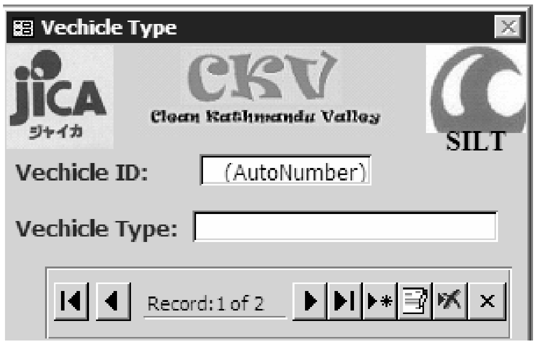
User Name –
Name of the user who granted to operate this application.

Password –
Password for the user

Confirm Password –
Retype of the same password

2.2.2.6 Vehicle Type Entry

Vehicle Type can be entered through Master table.

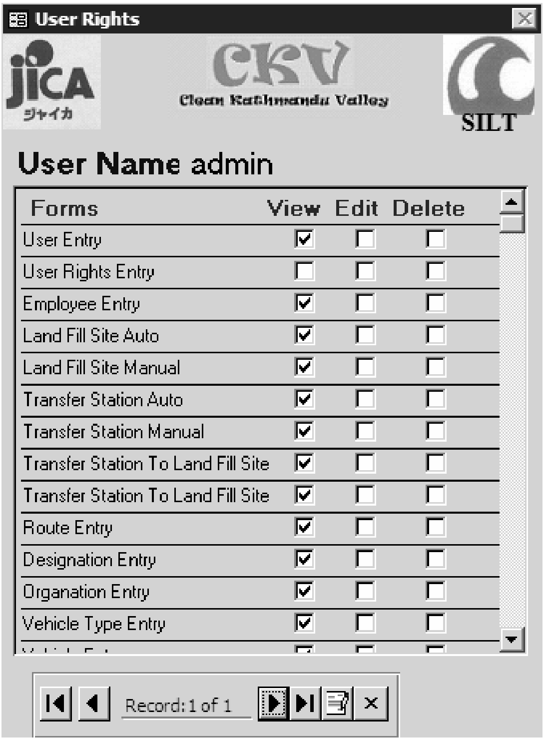


Vehicle ID –
Identification number for vehicle type

Vehicle Type –
Type of the Vehicle

2.2.2.7 User Rights Entry

To give the access to view, edit and delete records in the particular form for the particular user. There are three types of access on the form which are as follows:



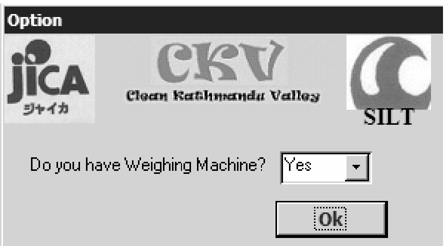
View –
Enabling View, the user can only be able to view records on the particular data entry form.

Edit –
Enabling Edit, the user can be able to edit records on the particular data entry form.

Delete –
Enabling Delete, the user can be able to delete records on the particular data entry form.

2.2.2.8 Option

Option form is to make the weighing scale as default in entry form. If the organization has the weighing scale, choose "Yes", otherwise "No".



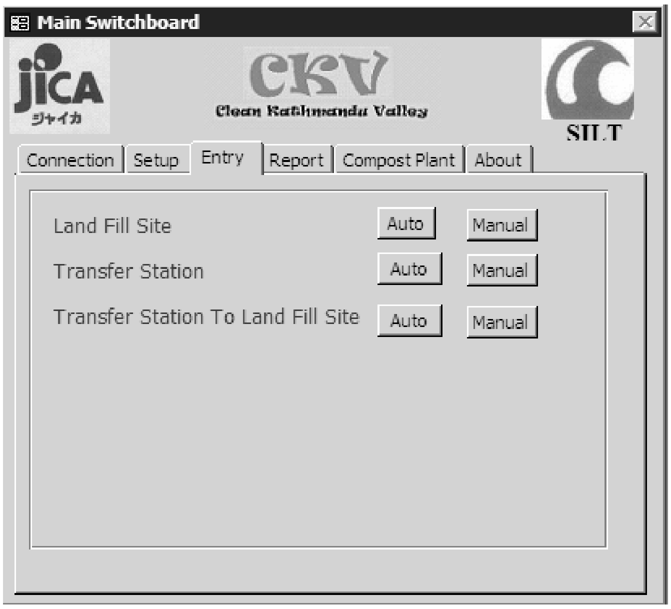
2.2.3 Entry Tab

Entry Tab is used to enter the solid waste data or records into the databases from landfill site, transfer station and transfer station to landfill site. There are two types of mode to enter data.

Manual - User can input the time of vehicle arrived.

Auto - User can't entry the time of vehicle arrived, system will generate the time automatically. So, it can give correct information.

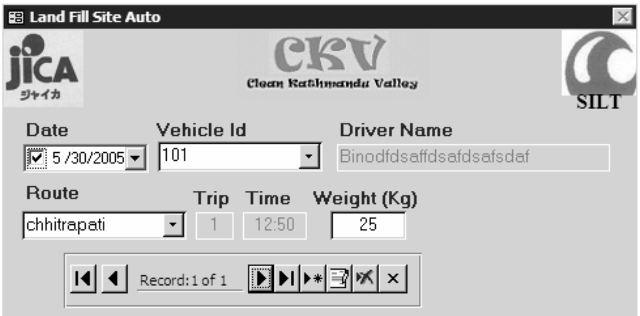
This form can be used for those who have weighing scale and even those who don't have weighing scale. Before using this form, user have to change some option from option entry.



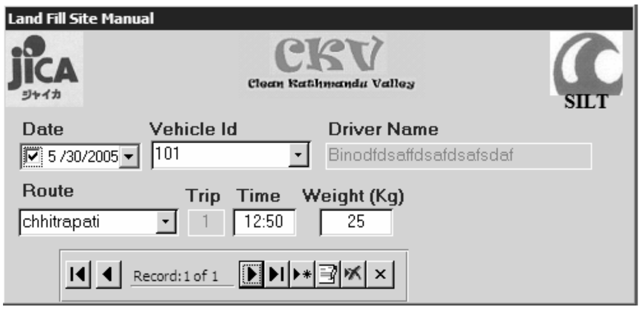
2.2.3.1 Land Fill Site

This function is used to record waste collection at the Landfill Site. There are the following three scenarios:

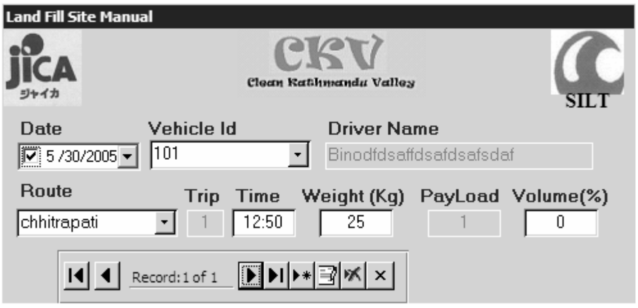
- With Weighing Machine and Auto Time



- With Weighing Machine and Manual Time



- Without Weighing Machine and Auto Time



Features:

Date –
Date of arrival of vehicle.

Vehicle ID –
Identification of Vehicle (if the vehicle Id is not listed in the box, add from the Vehicle Entry)

Driver Name –
Name of Driver (user do not need to enter)

Route –
Route of the vehicle (if the route is not listed in the box, add from Route Entry)

Trip –
No of trip of the vehicle per day. The trip no will be calculated automatically.

Time –
Time of the vehicle entered in the sites.

Weight –
Total Weight of the garbage. If the site has not a weighing machine they can entry directly otherwise they can't input.

Payload –
Payload of the vehicle. User do not need to enter payload in this form. Whenever user select the Vehicle Id, it give the value as per vehicle.

Volume –
Volume of the wastage in percentage.

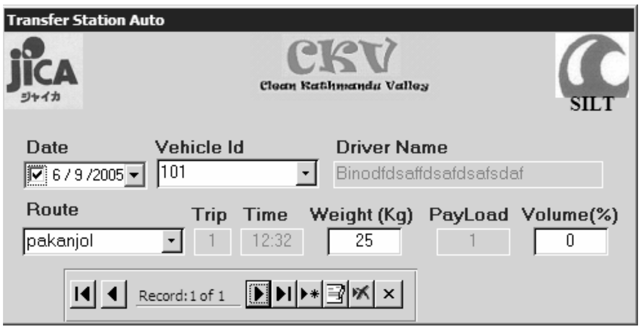
2.2.3.2 Transfer Station

This function is used to record waste collection at Transfer Station. There are the following three scenarios:

- With Weighing Machine and Auto Time

- With Weighing Machine and Manual Time

- Without Weighing Machine and Auto Time



Features:

Date –
Date of arrival of vehicle.

Vehicle ID –
Identification of Vehicle (if the vehicle Id is not listed in the box, add from the Vehicle Entry)

Driver Name –
Name of Driver (user do not need to enter)

Route –
Route of the vehicle (if the route is not listed in the box, add from Route Entry)

Trip –
No of trip of the vehicle per day. The trip no will be calculated automatically.

Time –
Time of the vehicle entered in the sites.

Weight –
Total Weight of the garbage. If the site has not a weighing machine they can entry directly otherwise they can't input.

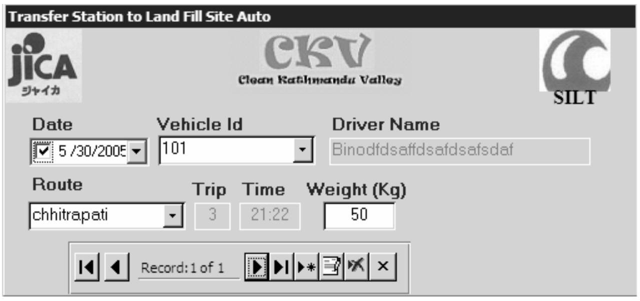
Payload –
Payload of the vehicle. User do not need to enter payload in this form. Whenever user select the Vehicle Id, it give the value as per vehicle.

Volume –
Volume of the wastage in percentage.

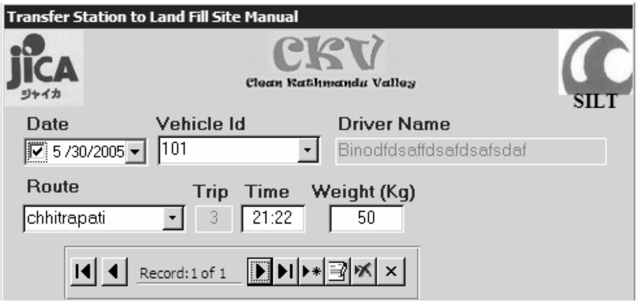
2.2.3.3 Transfer Station to Land Fill Site

This function is used to record waste collection from Transfer Station to Landfill Site. There will be following three scenarios.

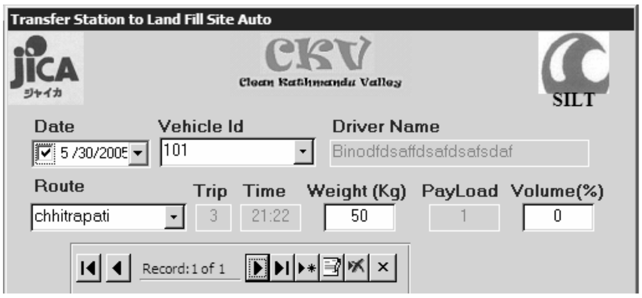
- With Weighing Machine and Auto Time



- With Weighing Machine and Manual Time



- Without Weighing Machine and Auto Time



Features:

Date –
Date of arrival of vehicle.

Vehicle ID –
Identification of Vehicle (if the vehicle Id is not listed in the box, add from the Vehicle Entry)

Driver Name –
Name of Driver (user do not need to enter)

Route –
Route of the vehicle (if the route is not listed in the box, add from Route Entry)

Trip –
No of trip of the vehicle per day. The trip no will be calculated automatically.

Time –
Time of the vehicle entered in the sites.

Weight –
Total Weight of the garbage. If the site has not a weighing machine they can entry directly otherwise they can't input.

Payload –
Payload of the vehicle. User do not need to enter payload in this form. Whenever user select the Vehicle Id, it give the value as per vehicle.

Volume –
Volume of the wastage in percentage.

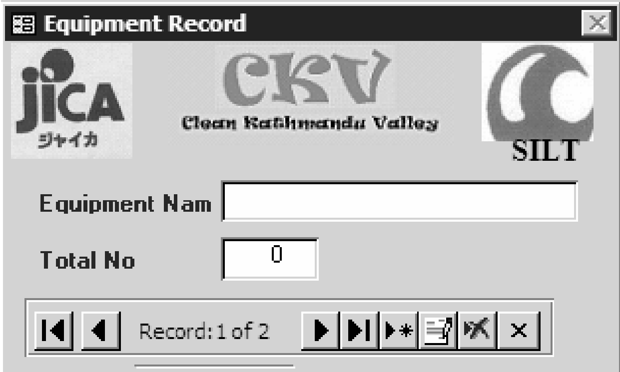
2.2.4 Composting Facility Tab

This Composting Facility Tab is used to enter the data related to composting facility, which are as follows:

- Equipment Entry
- Waste Inflow
- Compost Sales
- Compost Recycle Sales
- Rejected Waste
- Expenses

2.2.4.1 Equipment Entry

Equipment Entry is used to record the equipment items in the composting facility.

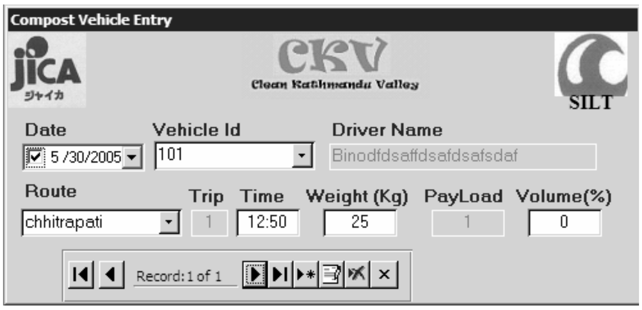


Equipment Name -
Name of the equipment

Total No -
Total number of equipment used.

2.2.4.2 Waste Inflow

This function is used to record waste collection at composting facility.



Features:

Date –
Date of arrival of vehicle.

Vehicle ID –
Identification of Vehicle (if the vehicle Id is not listed in the box, add from the Vehicle Entry)

Driver Name –
Name of Driver (user do not need to enter)

Route –
Route of the vehicle (if the route is not listed in the box, add from Route Entry)

Trip –
No of trip of the vehicle per day. The trip no will be calculated automatically.

Time –
Time of the vehicle entered in the sites.

Weight –
Total Weight of the garbage. If the site has not a weighing machine they can entry directly otherwise they can't input.

Payload –
Payload of the vehicle. User do not need to enter payload in this form. Whenever user select the Vehicle Id, it give the value as per vehicle.

Volume –
Volume of the wastage in percentage.

2.2.4.3 Compost Sales

This form is used to record waste sales at composting facility.

Date –
Sold date
Quantity –
Total number of quantity sold
Rate –
Rate of the compost per Kg.
Amount –
Total amount

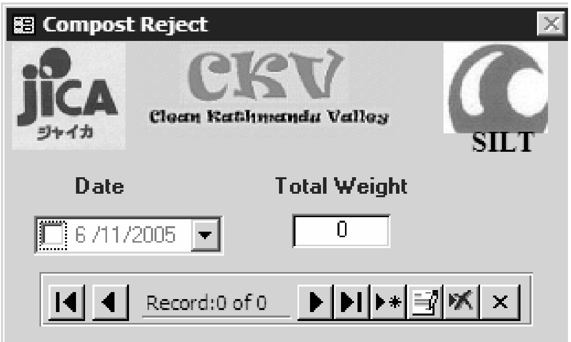
2.2.4.4 Recyclable Materials Sales

This form is used to record Recyclable Materials sold at the composting facility.

Date –
Date of recyclable material sold.
Type –
Type of recyclable material.
Total weight -
Total weight of recyclable material.

2.2.4.5 Rejected Waste

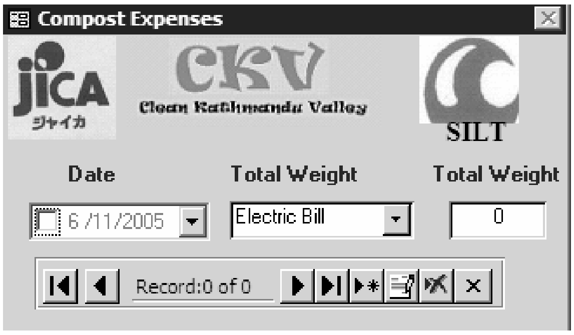
This form is used to record the rejected waste. This form is to be entered every day.



Date –
Date of the rejected waste recorded.
Total weight -
Total rejected waste per day.

2.2.4.6 Expenses

This form is used to record the expenses made at the composting facility.

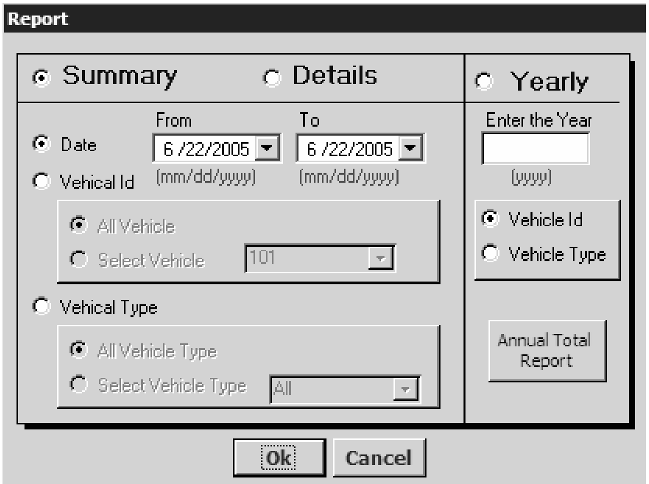


Date –
Date of the expense.
Type –
Expense type
Amount –
Total expense amount.

2.2.5 Reports Tab

Reports are divided into three major parts, which are as follows:

- Details Reports
- Summary Reports
- Yearly Reports

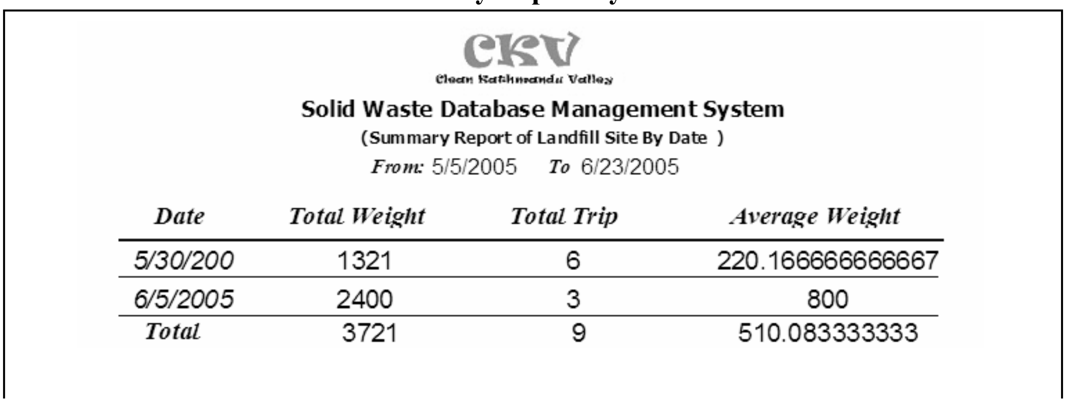


2.2.5.1 Summary Report

The summary report can be generated on date, vehicle ID and vehicle type in any date range in any database. It is form "from Date" to "To Date" or monthly or weekly. Choose details button. It shows three options:

- Date
- Vehicle ID
- Vehicle Type

Summary Report by date



Clean Kathmandu Valley

Solid Waste Database Management System

(Summary Report of Landfill Site By Date)

From: 5/5/2005 *To* 6/23/2005

Date	*Total Weight*	*Total Trip*	*Average Weight*
5/30/200	1321	6	220.166666666667
6/5/2005	2400	3	800
Total	3721	9	510.083333333

Summary Report by Vehicle ID

CKV
Clean Kathmandu Valley

Solid Waste Database Management System

(Summary Report of Transfer Station By Vehicle)

From: 5/5/2005 *To* 6/23/2005

Vehicle Id	*Total Weight*	*Total Trip*	*Average Weight*
101	50	2	25
15256	3025	4	756.25
156	646	3	215.33333
Total	3721	9	332.194444444

Summary Report by Vehicle Type

CKV
Clean Kathmandu Valley

Solid Waste Database Management System

(Summary Report of Land Fill Site By Vehicle Type)

From: 5/5/2005 *To* 6/23/2005

Vehicle Id	*Total Weight*	*Total Trip*	*Average Weight*
car	3025	4	756.25
motor	646	3	15.33333333333
Truck	50	2	25
Total	3721	9	332.19444444

2.2.5.2 Detailed Report

The detailed report can be generated on date, vehicle ID and vehicle type in any date range in any database. It is from "From Date" to "To Date" or monthly or weekly. Choose details button. It shows three options:

- Date
- Vehicle Id
- Vehicle Type

Details Report by date

CKV
Clean Kathmandu Valley

Solid Waste Database Management System

(Detail Report of Landfill Site)

From: 5/5/2005 *To* 6/23/2005

VehicleId	Route	Tripno	Time	Weight	Driver
Date 5/30/2005					
101	chhitrapati	2	13:50	25	Binodfdsaffdsafdsafsdaf
101	chhitrapati	1	12:50	25	Binodfdsaffdsafdsafsdaf
15256	chhitrapati	2		900	Kumar
15256	chhitrapati	1	12:50	25	Kumar
156	chhitrapati	2	12:50	90	Shyam
156	chhitrapati	1		256	Shyam
			Total	1321	
Date 6/5/2005					
15256	chhitrapati	2	12:50	900	Kumar
15256	chhitrapati	1	12:55	1200	Kumar

Details Report by Vehicle ID

CKV
Clean Kathmandu Valley

Solid Waste Database Management System

(LandFill Site Report By Vehicle)

From: 5/5/2005 *To* 6/23/2005

Date	Route	Trip No	Time	Weight	Driver
Vehicle Number 101					
5/30/2005	chhitrapati	2	13:50	25	Binodfdsaffdsafdsafsdaf
5/30/2005	chhitrapati	1	12:50	25	Binodfdsaffdsafdsafsdaf
			Total	50	
Vehicle Number 15256					
5/30/2005	chhitrapati	2		900	Kumar
5/30/2005	chhitrapati	1	12:50	25	Kumar
6/5/2005	chhitrapati	2	12:50	900	Kumar
6/5/2005	chhitrapati	1	12:55	1200	Kumar
			Total	3025	
Vehicle Number 156					
5/30/2005	chhitrapati	2	12:50	90	Shyam

Details Report by Vehicle Type

Clean Kathmandu Valley

Solid Waste Database Management System

(LandFill Site Report By Vehicle Type)

From: 5/5/2005 *To* 6/23/2005

	Date	Route	Trip No	Time	Weight	Driver
Vehicle Type *Truck*						
	5/30/2005	chhitrapati	2	13:50	25	Binodfdsaffdsafdsafsdaf
	5/30/2005	chhitrapati	1	12:50	25	Binodfdsaffdsafdsafsdaf
				Total	50	
Vehicle Type *car*						
	5/30/2005	chhitrapati	2		900	Kumar
	5/30/2005	chhitrapati	1	12:50	25	Kumar
	6/5/2005	chhitrapati	2	12:50	900	Kumar
	6/5/2005	chhitrapati	1	12:55	1200	Kumar
				Total	3025	
Vehicle Type *motor*						
	5/30/2005	chhitrapati	2	12:50	90	Shyam

3. System Required

System requirements to operate SWDMS are follows:

- Windows 9X/NT 4/2000/XP/2003
- Microsoft Access 2000 or greater version
- 8 MB RAM (Windows 9X)
- 32 MB RAM (Windows NT 4/2000/XP/2003)
- 10 MB Free Disk Space