Supporting Report F

Potential of Hydropower at Banchare Danda

Supporting Report F: Potential of Hydropower at Banchare Danda

(1) Background

Supply of electricity to the Banchare Danda site is one of the most important tasks for sustainable operation and maintenance of the facilities. Unfortunately electricity supply is not stable in Nepal due to lack of electric generation capacity against the demand especially during dry season. In the case of the Sisdol site, power supply from the national grid has not been started yet due to delay of installation of power supply line. For the Banchare Danda site, the present river course will be diverted with 20 m drop between upstream and downstream. Small hydropower has been developed around the world using such small head of water flow. Hydropower is also known as one of the clean energy system. Hydropower potential at the Banchare Danda site was briefly studied in order to grasp its suitability of power supply scheme for the Banchare Danda site.

If higher hydropower potential is found at the Banchare Danda site, surplus electricity generated by hydropower can be sold to the Nepal Electricity Authority (hereinafter, NEA). A NEA manager said that present electricity supply does not satisfy the peak demand between 6~9 AM and 6~9 PM. The lack of power supply is estimated at 75 MW in the morning time and 150 MW in the evening time. Hence, electricity generated at the power station of public or corporate body will be purchased by NEA. It is expected that the benefit from sale of the electricity to NEA will be effective for enhancement of SWMRMC financial condition.

(2) Related Law and Regulation

Related regulations on the hydropower project are summarized as follows:

1) Electricity Act, 1992

The Electricity Act which was announced on 17th December, 1992 regulates the study and construction of power station and the electricity services. The related regulations of the Electricity Act for micro hydropower are summarized as follows:

1. No license shall be required to be obtained by a national or corporate body for the generation, transmission or distribution of electricity up to 1,000 kW and for conducting necessary survey there of. However, information in this regard should be given to prescribed officer. In case of Kolpu Khola HPP it is Dhading District Development Committee.
2. The District Development committee issues the license within 30 days of receipt of application in case of license for conducting survey relating to electricity and within 120 days in case for generation, transmission or distribution of electricity.
3. The survey license will be issued for 5 years in maximum and for generation, transmission or distribution it may be of 50 years in maximum.

4. Royalty to be paid: The rate of royalty to be paid to HMG/N is Rs100 for each installed kW of electricity per year plus 2% of the average tariff per unit (per kWh) for a term of up to 15 years from the commercial operation date.
5. From year 16th the royalty will be Rs1,000 for each installed kW of electricity per year plus 10% of average tariff per unit.
6. No income tax will be levied for generation, transmission and distribution of hydroelectricity up to 1,000 kW.

2) Water Resources Act, 1992

The Water Resources Act which was announced on 17th December, 1992 regulates the rational utilization, conservation management and development of the water resources in Nepal in the form of surface water, underground water or in whatsoever form. This act is also expedient to prevent pollution of water resources. A person or a corporate body shall submit an application to the prevailing organization in order to get license for commencement of study and utilization of water resources. But license for survey and construction of hydropower station shall be governed by the prevailing laws.

3) NEA Related Rules

NEA will purchase electricity from Independent Power Producers (IPPs) having installed capacity up to 5 MW. The rate of purchase of such electricity has been fixed to Rs. 3.00 per kWh during wet season and Rs. 4.25 for dry season. The dry season is considered to be from February to May. This rule was introduced in 2055 BS with the provision of increase by 6% per annum for 5 years. However, it is not a law but standard practice. Calculating from above mentioned rate, the present rate of sell of electricity per kWh is Rs. 3.90 for wet period and Rs. 5.525 for dry period.

(3) Potential of Hydropower

The hydropower potential of the proposed site depends on the available magnitude and distribution of the river flow and the head. The available magnitude and distribution of river flow is decided in consideration of dependable mean flow rate of the Banchare Danda site. But there is no discharge data of the Kolpu Khola so that the long term flow rate shall be calculated employing empirical computation method namely HYFEST which has been developed by DHM. The estimation is done inputting data of annual precipitation in the catchmant and physiographic characteristics of the catchment. The mean annual precipitation and physiographic characteristics of the catchment at the Banchare Danda site are as follows:

Catchment Area:	38 km2
Area below the elevation of 5,000 m:	38 km2
Area below the elevation of 3,000 m:	38 km2
Mean Annual Precipitation:	2,654 mm (23years rainfall data)

The long term mean discharge in each month was estimated as shown in Table 1.

Table 1 Long Term Flow Rate of Kolpu Khola at Banchare Danda

(unit: m3/sec)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Discharge	0.51	0.44	0.38	0.36	0.46	2.04	6.26	7.73	6.08	2.62	1.26	0.82

Source: JICA Study Team

The dependable discharge was estimated as follows:

Dependability (%)	Discharge (m3/sec)
0	17.39
5	9.05
20	5.02
40	1.29
60	0.63
65	0.56
80	0.35
95	0.22
100	0.17

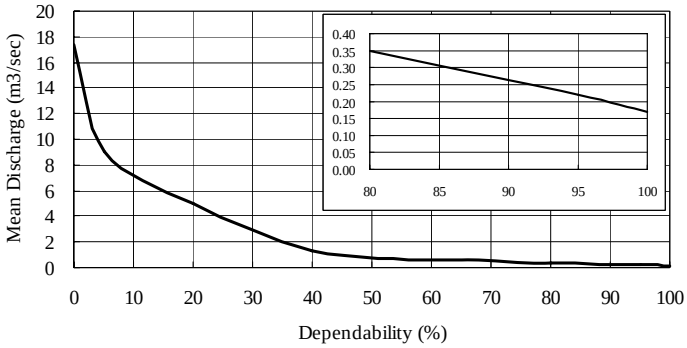


Figure 1 Dependable Discharge at Banchare Danda Landfill Site

The hydropower potential at the level of desk study is carried out by the following formula:

$P = 9.8 \times E_f \times Hg \times Q$

where, P : Power output (kW)
Q : Power discharge (m^3/sec)
E_f : Combined efficiency of power plant
9.8 : Acceleration of gravity (m/sec^2)
Hg : Effective Head (m)

Main purpose of the hydropower is electricity supply for the operation and maintenance of the Banchare Danda site. The equipments installed in the landfill site shall be constantly operated through a year so that electricity shall also be supplied stably. High dependable discharge rate between 90~95% exceedance occurrence is normally selected as a potential of hydropower project. The river flow with exceedance occurrence of 95% means that the river flow possibly appears in 347 days a year. The 95% dependable discharge is 0.22m^3/sec as shown in Figure 1.

The hydropower potential under the 95% dependable discharge is computed at 30 kW as shown below.

$P_{95} = 9.8 \times E_f \times Hg \times Q_{95}$
$= 9.8 \times 0.72 \times 19.11 \times 0.22$
$= 29.66$ kW

where, P_{95} : Power output with 95% dependability (kW)
Q_{95} : Power discharge with 95% dependability (m^3/sec)

E_f : Combined efficiency of power plant (=0.72)
9.8 : Acceleration of gravity (m/sec^2)
Hg : Effective Head (m)
(= Gross Head – Head Loss (7-9% of gross head))

It should be discussed whether the hydropower capacity of 30 kW satisfies the necessary demand of electricity for operation of equipments at the Banchare Danda site.

Sale of surplus electricity can be considered during monsoon season because the mean flow rate becomes 10~20 times of the flow rate during dry season as shown in Table 1. However, the bigger the installation capacity of the hydropower system is, the less chance the hydropower is fully operated in. The construction cost may increase in accordance with installation capacity as well as the operation and maintenance cost. Hence, the maximum installation capacity shall be carefully studied and discussed among the concerned organizations in consideration of the use of electricity if the hydropower is adopted.

(4) Conceptual Layout Plan

The hydropower scheme is mainly composed of the following structures:

a) Intake

For convenience of intake of water, a regulating reservoir will be recommended before diversion channel in order to make intake stable and settle suspended solids. Intake is installed on the present river bank beside the spillway with trashrack preventing debris flow-in. The sill elevation of the intake shall be made higher than design river bed. Sluice gate shall be installed at the intake.

b) Headrace Pipe

Headrace pipe which conveys intake water to the power house is installed along the route of diversion channel. According to geological condition, the headrace pipe shall be installed on the ground because digging bed rocks is costly. Steel pipe is normally utilized to the headrace pipe because of higher strength against water pressure and external force under exposure installation.

c) Powerhouse

The location of powerhouse is planned at the small terrace land on left bank in the 200 m downstream of diversion section. Present elevation of the land is about 1 m lower from estimated flood water level so that embankment and river training work should be done. The powerhouse should be designed for enough installation space of hydropower turbine, generator, control equipments and administration office. Access road to the powerhouse should be provided for maintenance purpose only.

The conceptual layout plan is shown in Figure 2.

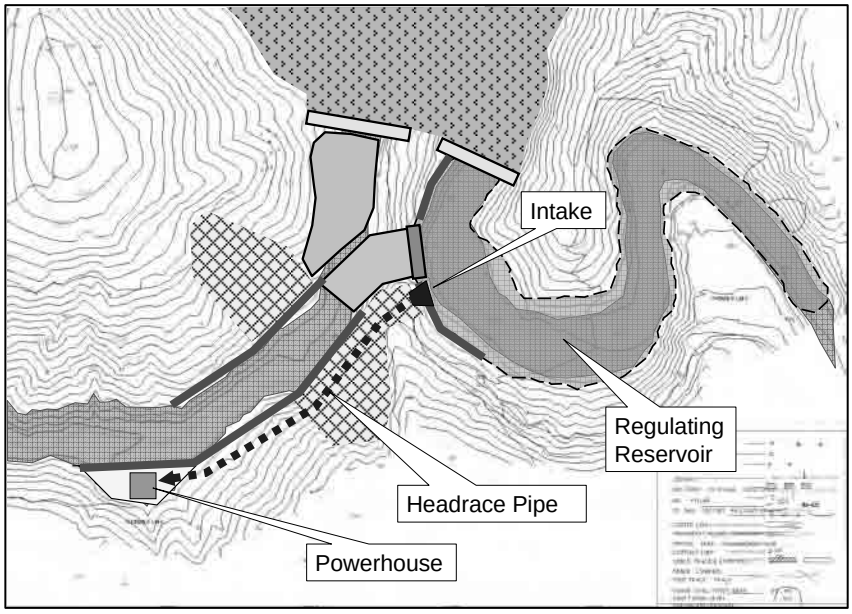


Figure 2 Conceptual Layout Plan of Hydropower

(5) Conclusion and Recommendation

The conceptual study on the hydropower potential is concluded as follows:

1. Hydropower potential at the Banchare Danda site was estimated at 30 kW with 95% dependability.
2. The river flow rate is various through a year so that higher hydropower potential during rainy season can be expected. But dependability of higher flow rate is lower through a year.
3. According to the low of electricity in Nepal, surplus electricity generated can be purchased by NEA.

The recommendation for the further study is as follows:

1. Estimated hydropower potential shall be evaluated on the basis of necessary demand of installation facilities at the Banchare Danda site.
2. The installed hydropower capacity shall be studied on the basis of desirable electricity use.

Supporting Report G

Supplemental Environmental Survey

Supporting Report G: Supplemental Environmental Survey

(1) Objectives

The supplemental survey was carried out paying attention to the water quality around the proposed long-term landfill site. The water sampling and quality analysis targeted to surface water of the Kolpu Khola and ground water along the river course. Water sampling points were set at 5 locations including three points in the river and other two in groundwater using geological survey boreholes. The water sampling was done twice in each dry season and rainy season as shown in the following table.

Table -1 Water Sampling Schedule

Season	Dry Season		Rainy Season	
	1st	2nd	1st	2nd
Date	23 February, 2006	29 March,2006	17 June,2006	25 July, 2006

Source: JICA Study Team

The parameters to be analyzed, which have been selected based on the Generic Standard Part I Tolerance Limit for Industrial Effluent to be Discharged into Surface Wasters, MOPE and the EIA Guideline are shown below:

Table -2 Parameters to be Analyzed

Parameters		Survey Time		Remarks	
		1st	2nd	GS*[1]	EIA*[2]
Field measurement	Weather, Air temperature	O	O	-	-
	River flow, Discharge, Groundwater level	O	O	-	-
	Water temperature, Color, Transparency, Odor, Appearance	O	O	*	*
	pH	O	O	*	*
	Dissolved Oxygen (DO)	O	O		
	Electric Conductivity (EC)	O	O		*
Laboratory analysis	Total Dissolved Solids (TDS)	O	O		*
	Total Suspended Solids (TSS)	O	O	*	
	Hydrogen Carbonate (HCO3-)	O	O		*
	Dissolved Oxygen Carbon (DOC) *3	O	O		*
	Biochemical Oxygen Demand (BOD)	O	O	*	*
	Chemical Oxygen Demand (COD)	O	O	*	*
	Oxidizability with KMnO4 as O	O	O		*
	Chloride ion (Cl-)	O	O		*
	Calcium ion (Ca++)	O	O		*
	Sodium ion (Na++)	O	O		
	Sulfate ion (SO4-)	O	O		*
	Sulfite ion (SO3-)	O	O		*
	Sulfide (as S)	O	O	*	
	Phenol Compounds	O		*	*
	Cyanides (as CN) *3	O		*	
	Fluorides (as F)	O		*	
	Arsenic (as As)	O		*	

	Cadmium (as Cd)	O		*	*
	Total Chromium	O			*
	Hexavalent Chromium (as Cr)	O		*	
	Copper (as Cu)	O		*	*
	Lead (as Pb)	O		*	*
	Mercury (as Hg)	O		*	*
	Nickel (as Ni)	O		*	*
	Selenium (as Se)	O		*	
	Zinc (as Zn)	O		*	*
	Iron (as Fe)	O			*
	Manganese (as Mg)	O			*
	Ammonia Nitrogen (NH4-N)	O	O	*	*
	Nitrate Nitrogen (NO3-N)	O	O		*
	Nitrite Nitrogen (NO2-N)	O	O		*
	Total Nitrogen (T-N)	O	O		*
	Phosphorous Phosphate (PO4-P)	O	O		*
	Oil and Grease	O	O	*	
	Coliform Group Number	O	O		

*1 Generic Standard Part I Tolerance Limit for Industrial Effluent to be Discharged into Surface Wasters, MOPE

*2 Draft National Environmental Impact Assessment (EIA) Guidelines for Solid Waste Management Project for Municipalities of Nepal, SWMRMC

*3 If equipment and facility are not available for analyzing some parameters, explain it in the proposal and quotation.

(2) Result of the Water Quality Survey

A result of the water quality survey is summarized in the following table.

Table -3 Water Quality Analysis Result

Parameter	River		Ground Water	
	Dry	Rainy	Dry	Rainy
pH	8.522	8.415	7.683	7.425
Electrical Conductivity	196.833	181.667	223.750	240.500
Dissolved Oxygen (DO)	8.733	8.317	4.725	3.000
Total Dissolved Solids (TDS)	131.000	115.667	138.750	137.500
Total Suspended Solids (TSS)	327.167	80.833	1858.750	2072.500
Hydrogen Carbonate ($HCO3^-$)	74.333	60.667	87.500	65.000
Biochemical Oxygen Demand (BOD)	7.667	4.417	18.625	17.500
Chemical Oxygen Demand (COD)	20.213	28.822	65.375	80.400
Oxidizability with KMnO4 as O	14.008	21.067	34.555	39.165
Chloride ion (Cl^-)	2.000	2.167	4.250	2.000
Calcium ion (Ca^{++})	32.875	30.565	34.855	27.255
Sodium ion (Na^{++})	7.827	5.708	9.450	7.055
Sulfate ion (SO_4^-)	<2	<2	<2	<2
Sulfite ion (SO_3^-)	2.333	1.083	4.250	3.000
Sulfide as S	0.400	<0.4	1.100	<0.4
Phenol Compounds	0.077	0.047	0.160	0.040
Fluorides as F	0.487	0.247	1.210	0.640
Arsenic as As	0.005	0.005	0.006	0.006
Cadmium as Cd	ND	ND	ND	ND
Total Chromium	ND	ND	ND	ND
Hexavalent Chromium as Cr^{+6}	ND	ND	0.020	ND
Copper as Cu	ND	ND	0.222	ND

Lead as Pb	ND	ND	1.725	2.300
Mercurry as Hg	0.002	0.002	ND	0.002
Nickel as Ni	ND	ND	0.053	ND
Selenium as Se	ND	ND	-	ND
Zinc as Zn	0.013	0.013	0.299	0.057
Iron as Fe	0.170	0.170	47.310	13.080
Manganese as Mn	0.050	0.050	1.385	0.690
Ammonia- Nitrogen (NH_4-N)	1.668	0.195	1.440	0.630
Nitrate Nitrogen (NO_3-N)	0.410	0.166	1.035	1.220
Nitrite Nitrogen (NO_2-N)	0.012	0.017	0.020	0.040
Total Nitrogen (T-N)	5.393	1.408	6.825	4.060
Phosphorus Phosphate (PO_4-P)	0.182	0.160	0.293	0.185
Oil & Grease	0.900	0.967	0.850	1.900
Fecal Coliform	2400	329	5100	584

Source: JICA Study Team

According to the result, the water quality in dry season is generally worse than that in rainy season because concentration of materials in the water becomes higher relatively during small flow rate in the river. The concentration of materials be surveyed in the groundwater is found higher than surface water. The water of the borehole placed in the vicinity of the river course is affected by the river water quality and is stagnant for a long time so that the water is contaminated gradually. Present water quality is not suitable for the drinking purpose without application of the advanced water purification process in spite of water in the rainy season. But it is enough water quality for the agricultural water use. It is recommended that such water quality survey should be conducted for a long time for formulation of accurate parameters for the landfill site operation m0nitoring. The actual results of the water quality survey is shown in Table-4 ~ 7.

Table -4 Water Quality Survey Result (1/4)

Lab. Regd. No.:1725 - 1729/(062-063) Code : WW Payment:T

Client : GEOCE
Address : Patan, Lalitpur
Sampled By : ENPHO

Source of Sample : River/Borehole
Location/Area : Banchare Danda
Date of Received : 23rd February 2006
Date of Analysis : 23 - 17th March 2006

PHYSICO-CHEMICAL ANALYSIS

Parameters	Unit	Sample ID				
		LR-1725: Up S.	LR-1726: M.P.	LR-1727: BH3	LR-1728: BH4	LR-1729: DS
pH	-	8.35	8.45	7.84	7.29	8.65
Electrical Conductivity	uS/cm	190.0	183.0	225.0	240.0	180.0
Dissolved Oxygen (DO)	mg/L	8.50	8.20	3.50	3.90	8.30
Total Dissolved Solids (TDS)	mg/L	138.0	125.0	159.0	167.0	140.0
Total Suspended Solids (TSS)	mg/L	295.0	277.0	1787	2894	405.0
Hydrogen Carbonate ($HCO3^-$)	mg/L	76.00	74.00	110.0	92.00	82.00
Biochemical Oxygen Demand (BOD)	mg/L	10.00	10.00	27.50	22.00	9.50
Chemical Oxygen Demand (COD)	mg/L	30.00	30.50	105.0	55.00	30.00
Oxidizability with KMnO4 as O	mg/L	18.96	20.22	39.00	44.87	21.49
Chloride ion (Cl^-)	mg/L	1.00	2.00	2.00	7.00	3.00
Calcium ion (Ca^{++})	mg/L	33.67	32.06	36.87	34.47	28.86
Sodium ion (Na^{++})	mg/L	7.76	6.66	10.00	9.52	6.72
Sulfate ion (SO_4^-)	mg/L	<2	<2	<2	<2	<2
Sulfite ion (SO_3^-)	mg/L	3.50	2.00	5.50	5.00	2.50
Sulfide as S	mg/L	<0.40	<0.40	2.00	1.20	<0.40
Phenol Compounds	mg/L	0.09	0.08	0.17	0.15	0.06
Fluorides as F	mg/L	0.49	0.47	1.22	1.20	0.50
Arsenic as As	mg/L	(ND<0.005)	(ND<0.005)	0.006	(ND<0.005)	(ND<0.005)
Cadmium as Cd	mg/L	(ND<0.001)	(ND<0.001)	(ND<0.001)	(ND<0.001)	(ND<0.001)
Total Chromium	mg/L	0.03	(ND<0.02)	(ND<0.02)	(ND<0.02)	(ND<0.02)
Hexavalent Chromium as Cr^{+6}	mg/L	(ND<0.02)	(ND<0.02)	(ND<0.02)	0.02	0.01
Copper as Cu	mg/L	(ND<0.02)	(ND<0.02)	0.29	0.15	(ND<0.02)
Lead as Pb	mg/L	(ND<0.01)	(ND<0.01)	2.13	1.32	(ND<0.01)
Mercurry as Hg	mg/L	(ND<0.001)	(ND<0.001)	(ND<0.001)	(ND<0.001)	(ND<0.001)
Nickel as Ni	mg/L	0.02	0.01	0.08	0.03	0.01
Selenium as Se	mg/L	-	-	-	-	-
Zinc as Zn	mg/L	0.01	0.02	0.37	0.23	0.03
Iron as Fe	mg/L	5.49	6.52	66.85	27.77	5.65
Manganese as Mn	mg/L	0.21	0.13	1.89	0.88	0.18
Ammonia- Nitrogen (NH_4-N)	mg/L	0.17	0.11	0.99	0.96	0.18
Nitrate Nitrogen (NO_3-N)	mg/L	0.24	0.22	0.15	0.07	0.16
Nitrite Nitrogen (NO_2-N)	mg/L	0.01	0.01	0.02	0.02	0.02
Total Nitrogen (T-N)	mg/L	-	-	-	-	-
Phosphorus Phosphate (PO_4-P)	mg/L	0.11	0.10	0.19	0.43	0.35
Oil & Grease	mg/L	0.20	0.40	0.20	0.40	0.40
MICROBIOLOGICAL ANALYSIS						
Fecal Coliform	CFU/100ml	1400	1800	5800	5400	3800

Note) LR-1725: Up Stream, LR-1726: Mid Point, LR-1727: Borehole3, LR-1728: Borehole 4, LR-1729: Down Stream

Table -5 Water Quality Survey Result (2/4)

Lab. Regd. No.:1873 - 1877/(062-063) Code : WW Payment:T

Client : GEOCE
Address : Patan, Lalitpur
Sampled By : ENPHO

Source of Sample : River/Borehole
Location/Area : Banchare Danda
Date of Received : 29th March 2006
Date of Analysis : 29 - 5th April 2006

PHYSICO-CHEMICAL ANALYSIS

Parameters	Unit	Sample ID				
		LR-1873: Up S.	LR-1874: M.P.	LR-1875: D.S	LR-1876: BH2	LR-1877: BH3
pH (19°C)	-	8.68	8.40	8.60	8.00	7.60
Electrical Conductivity	uS/cm	207	210	211	238	192
Dissolved Oxygen (DO)	mg/L	9.20	9.10	9.10	4.50	7.00
Total Dissolved Solids (TDS)	mg/L	126	135	122	133	96
Total Suspended Solids (TSS)	mg/L	340	356	290	1461	1293
Hydrogen Carbonate ($HCO3^-$)	mg/L	66	74	74	84	64
Biochemical Oxygen Demand (BOD)	mg/L	5.00	5.00	6.50	15.00	10.00
Chemical Oxygen Demand (COD)	mg/L	9.15	9.15	12.5	55.74	45.76
Oxidizability with KMnO4 as O	mg/L	6.32	7.58	9.48	28.44	25.91
Chloride ion (Cl^-)	mg/L	2	2	2	4	4
Calcium ion (Ca^{++})	mg/L	35.30	35.30	32.06	40.08	28.00
Sodium ion (Na^{++})	mg/L	7.47	9.40	8.95	9.20	9.08
Sulfate ion (SO_4^-)	mg/L	<2	<2	<2	<2	<2
Sulfite ion (SO_3^-)	mg/L	1.50	2.50	2.00	3.50	3.00
Sulfide as S	mg/L	<0.4	<0.4	0.40	0.80	0.40
Ammonia- Nitrogen (NH_4-N)	mg/L	3.05	2.53	3.97	2.44	1.37
Nitrate Nitrogen (NO_3-N)	mg/L	0.81	0.36	0.67	2.53	1.39
Nitrite Nitrogen (NO_2-N)	mg/L	0.01	0.01	0.01	0.02	0.02
Total Nitrogen (T-N)	mg/L	5.27	4.44	6.47	7.79	5.86
Phosphorus Phosphate (PO_4-P)	mg/L	0.11	0.13	0.29	0.21	0.34
Oil & Grease	mg/L	ND	ND	2.60	1.60	1.20
MICROBIOLOGICAL ANALYSIS						
Fecal Coliform	CFU/100ml	2100	2300	3000	4300	4900

Note) LR-1873: Kolpu Up Stream, LR-1874: Mid Point, LR-1875: Kolpu Down stream, LR-1876: Borehole - 2, LR-1877: Borehole - 3

NB:

ND: Not Detected

Table -6 Water Quality Survey Result (3/4)

Lab. Regd. No.: 2074 - 2077/(062-063) Code : WW Payment:T

Client : GEOCE
Address : Patan, Lalitpur
Sampled By : ENPHO

Source of Sample : River/Borehole
Location/Area : Banchare Danda
Date of Received : 17th June 2006
Date of Analysis : 17 - 27th June 2006

PHYSICO-CHEMICAL ANALYSIS

Parameters	Unit	Sample ID			
		(LR - 2074)	(LR - 2075)	(LR - 2076)	(LR - 2077)
pH (27°C)	-	8.93	8.89	8.87	7.60
Electrical Conductivity	uS/cm	338	224	225	221
Dissolved Oxygen (DO)	mg/L	8.70	8.50	8.70	2.40
Total Dissolved Solids (TDS)	mg/L	205	168	168	172
Total Suspended Solids (TSS)	mg/L	32.00	6.00	8.00	3876
Hydrogen Carbonate ($HCO3^-$)	mg/L	86.00	86.00	84.00	80.00
Biochemical Oxygen Demand (BOD)	mg/L	1.10	1.70	1.70	20.00
Chemical Oxygen Demand (COD)	mg/L	29.12	27.87	37.44	124.8
Oxidizability with KMnO4 as O	mg/L	20.22	18.96	22.12	49.93
Chloride ion (Cl^-)	mg/L	2	2	2	3
Calcium ion (Ca^{++})	mg/L	40.00	47.29	44.00	34.47
Sodium ion (Na^+)	mg/L	5.81	5.84	5.90	7.85
Sulfate ion (SO_4^-)	mg/L	<2	<2	<2	<2
Sulfite ion (SO_3)	mg/L	1.50	1.00	1.50	3.50
Sulfide as S	mg/L	<0.4	<0.4	<0.4	<0.4
Phenol Compounds	mg/L	0.05	0.04	0.05	0.04
Fluorides as F	mg/L	0.27	0.38	0.09	0.64
Arsenic as As	mg/L	0.007	ND (<0.005)	ND (<0.005)	0.006
Cadmium as Cd	mg/L	ND (<0.001)	ND (<0.001)	ND (<0.001)	ND (<0.001)
Total Chromium	mg/L	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)
Hexavalent Chromium as Cr^{+6}	mg/L	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)
Lead as Pb	mg/L	ND (<0.01)	ND (<0.01)	ND (<0.01)	2.30
Mercurry as Hg	mg/L	0.002	ND (<0.001)	0.003	0.002
Nickel as Ni	mg/L	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)
Selenium as Se	mg/L	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)
Zinc as Zn	mg/L	ND (<0.01)	0.02	ND (<0.01)	0.06
Iron as Fe	mg/L	0.35	0.12	ND (<0.05)	13.08
Manganese as Mn	mg/L	ND (<0.05)	0.05	ND (<0.05)	0.69
Ammonia- Nitrogen (NH_4-N)	mg/L	0.13	0.11	0.14	0.31
Nitrate Nitrogen (NO_3-N)	mg/L	0.24	0.23	0.18	0.10
Nitrite Nitrogen (NO_2-N)	mg/L	0.01	0.01	0.01	0.04
Total Nitrogen (T-N)	mg/L	1.08	1.19	1.31	2.83
Phosphorus Phosphate (PO_4-P)	mg/L	0.11	0.19	0.17	0.19
Oil & Grease	mg/L	1.40	0.80	0.40	2.00
MICROBIOLOGICAL ANALYSIS					
Fecal Coliform	CFU/100ml	428	560	552	1150

Note) LR - 2074: Up Stream, LR - 2075: Mid Point, LR -2076: Down Stream, LR - 2077: Borehole 2,

Table -7 Water Quality Survey Result (4/4)

Lab. Regd. No.: 85 - 88/(063-064) Code : WW Payment:T

Client : GEOCE
Address : Patan, Lalitpur
Sampled By : ENPHO

Source of Sample : River/Borehole
Location/Area : Banchare Danda
Date of Received : 25th July 2006
Date of Analysis : 25 - 5th August 2006

PHYSICO-CHEMICAL ANALYSIS

Parameters	Unit	(LR - 85: BH_{10})	(LR - 86: Up S)	(LR - 87: M.P.)	(LR - 88: D. S.)
pH (23°C)	-	7.25	7.90	7.94	7.96
Electrical Conductivity	uS/cm	260	100	101	102
Dissolved Oxygen (DO)	mg/L	3.60	8.00	8.00	8.00
Total Dissolved Solids (TDS)	mg/L	103	52	51	51
Total Suspended Solids (TSS)	mg/L	269	158	146	135
Hydrogen Carbonate ($HCO3^-$)	mg/L	50	38	38	32
Biochemical Oxygen Demand (BOD)	mg/L	15.00	7.00	7.00	8.00
Chemical Oxygen Demand (COD)	mg/L	36.00	25.00	27.50	26.00
Oxidizability with KMnO4 as O	mg/L	28.40	21.49	22.12	21.49
Chloride ion (Cl^-)	mg/L	1	2	2	3
Calcium ion (Ca^{++})	mg/L	20.04	16.83	19.24	16.03
Sodium ion (Na^+)	mg/L	6.26	5.42	5.27	6.01
Sulfate ion (SO_4)	mg/L	<2	<2	<2	<2
Sulfite ion (SO_3)	mg/L	2.50	1.00	0.50	1.00
Sulfide as S	mg/L	<0.4	<0.4	<0.4	<0.4
Ammonia- Nitrogen (NH_4-N)	mg/L	0.95	0.26	0.28	0.25
Nitrate Nitrogen (NO_3-N)	mg/L	2.34	ND (<0.05)	0.10	0.08
Nitrite Nitrogen (NO_2-N)	mg/L	0.04	0.02	0.02	0.03
Total Nitrogen (T-N)	mg/L	5.29	1.29	1.66	1.92
Phosphorus Phosphate (PO_4-P)	mg/L	0.18	0.16	0.15	0.18
Oil & Grease	mg/L	1.80	1.40	1.20	0.60
MICROBIOLOGICAL ANALYSIS					
Fecal Coliform	CFU/100ml	17	156	138	141

NB:

LR - 85: Borehole No. 10

LR - 86: Up Stream (River)

LR - 87: Mid Point

LR - 88: Down Stream (River)

ND: Not Detected

Supporting Report H

Financial Data

Supporting Report H-1: Development Cost

TOTAL CONSTRUCTION AND ENGINEERING COSTS

Banchare Danda Landfill Site

SUMMARY OF COST ESTIMATES

Item No.	Description	Amount (NRs.)	Remarks
A	**Civil Construction Cost**		
1	GROUND IMPROVEMENT	76,175,632.28	
2	BLOCK EMBANKMENT	3,209,828.45	
3	WASTE STORAGE DAM	753,091,785.21	
4	SADDLE DAM	12,873,816.56	
5	LINER SYSTEM FACILITY	69,552,657.82	
6	LEACHATE COLLECTION SYSTEM	19,144,941.23	
7	LEACHATE GAS VENT SYSTEM	3,842,929.26	
8	LEACHATE RECIRCULATION SYSTEM	157,140.46	
9	AERATION POND	59,601,718.13	
10	SEDIMENTATION POND	47,546,227.36	
11	BLOWER HOUSE	8,345,660.32	
12	OPERATION ROAD - 1 (TO LANDFILL SITE)	2,987,184.72	
13	OPERATION ROAD - 2 (TO SADDLE DAM)	3,609,514.87	
14	RAIN WATER DRAINAGE	9,361,393.85	
15	ADMINISTRATION BUILDING AND GARRAGE	4,311,380.22	
16	WEIGHBRIDGE	2,428,078.80	
17	VEHICLE WASH POOL	458,428.79	
18	GUARD HOUSE	469,225.03	
19	VERTICAL LINER PLAN (ALTERNATIVE)		18,937,800.45
20	RIVER DIVERSION	63,371,245.26	
21	FENCING WORKS	5,766,563.62	
22	UTILITIES	497,049.17	
23	BUFFER ZONE PLANTATION	1,440,000.00	
24	**Impact Monitoring Requirement**	1,747,000.00	
	SUB TOTAL A (PART 1 TO PART 24)	**1,149,989,401.38**	
B	**Engineering Cost (11.5 % of A)**	**132,248,781.16**	
	Detailed design and construction supervision (10 %)	114,998,940.14	
	Environmental Monitoring Unit and Training Skilled Development to Local People (1.5 %)	17,249,841.02	
	TOTAL	**1,282,238,182.54**	
	CONTINGENCIES 15%	**192,335,727.38**	
	Total	**1,474,573,909.92**	
	VAT 13 %	**191,694,608.29**	
	GRAND TOTAL	**1,666,268,518.21**	

In words: (One billion six hundred sixty six millions two hundred sixty eight thousand five hundred eighteen only)

Source: JICA Study Team

PHASE 1 - 1 CONSTRUCTION AND ENGINEERING COSTS

SUMMARY OF COST ESTIMATES

Phase-1, Stage - 1

Item No.	Description	Amount (NRs.)	Remarks
1	GROUND IMPROVEMENT	37,851,671.68	
2	BLOCK EMBANKMENT	2,212,707.61	
3	WASTE STORAGE DAM	407,047,892.80	
4	SADDLE DAM	-	Phase- 2
5	LINER SYSTEM FACILITY	32,495,778.52	
6	LEACHATE COLLECTION SYSTEM	15,054,794.26	
7	LEACHATE GAS VENT SYSTEM	3,219,053.11	
8	LEACHATE RECIRCULATION SYSTEM	157,140.46	
9	AERATION POND	59,601,718.13	
10	SEDIMENTATION POND	47,546,227.36	
11	BLOWER HOUSE	8,345,660.32	
12	OPERATION ROAD - 1 (TO LANDFILL SITE)	2,987,184.72	
13	OPERATION ROAD - 2 (TO SADDLE DAM)	-	Phase- 2
14	RAIN WATER DRAINAGE	9,361,393.85	
15	ADMINISTRATION BUILDING AND GARRAGE	4,311,380.22	
16	WEIGHBRIDGE	-	Phase- 2
17	VEHICLE WASH POOL	458,428.79	
18	GUARD HOUSE	469,225.03	
19	VERTICAL LINER PLAN (ALTERNATIVE)		9,637,470.92
20	RIVER DIVERSION	63,371,245.26	
21	FENCING WORKS	5,766,563.62	
22	UTILITIES	497,049.17	
23	BUFFER ZONE PLANTATION	1,440,000.00	100%
24	**Impact Monitoring Requirement**	1,747,000.00	100%
	SUB TOTAL A (PART 1 TO PART 24)	**703,942,114.88**	
B	**Engineering Cost (11.5 % of A)**	**80,953,343.21**	
	Detailed design and construction supervision (10 %)	70,394,211.49	
	Environmental Monitoring Unit and Training Skilled Development to Local People (1.5 %)	10,559,131.72	
	TOTAL	**784,895,458.09**	
	CONTINGENCIES 15%	**117,734,318.71**	
	Total	**902,629,776.81**	
	VAT 13 %	**117,341,870.99**	
	GRAND TOTAL	**1,019,971,647.79**	

In words:(One billion nineteen million nine hundred seventy one thousand six hundred forty seven only.)

Source: JICA Study Team

PHASE 1 - 2 CONSTRUCTION AND ENGINEERING COSTS

SUMMARY OF COST ESTIMATES

Phase-1, Stage - 2

Item No.	Description	Amount (NRs.)	Remarks
1	GROUND IMPROVEMENT	38,323,960.60	
2	BLOCK EMBANKMENT	997,120.85	
3	WASTE STORAGE DAM	135,608,810.61	
5	LINER SYSTEM FACILITY	37,056,879.30	
6	LEACHATE COLLECTION SYSTEM	4,090,146.97	
7	LEACHATE GAS VENT SYSTEM	623,876.14	
16	WEIGHBRIDGE	2,428,078.80	
19	VERTICAL LINER PLAN (ALTERNATIVE)		9,300,329.52
	SUB TOTAL A (PART 1 TO PART 24)	**219,128,873.27**	
B	**Engineering Cost (11.5 % of A)**	**25,199,820.43**	
	Detailed design and construction supervision (10 %)	21,912,887.33	
	Environmental Monitoring Unit and Training Skilled Development to Local People (1.5 %)	3,286,933.10	
	TOTAL	**244,328,693.70**	
	CONTINGENCIES 15%	**36,649,304.05**	
	Total	**280,977,997.75**	
	VAT 13 %	**36,527,139.71**	
	GRAND TOTAL	**317,505,137.46**	

In words: (Three hundred seventeen million five hundred five thousand one hundred thirty seven only.)

Source: JICA Study Team

PHASE 2 CONSTRUCTION AND ENGINEERING COSTS

SUMMARY OF COST ESTIMATES

Phase - 2

Item No.	Description	Amount (NRs.)	Remarks
3	WASTE STORAGE DAM	210,435,081.80	
4	SADDLE DAM	12,873,816.56	
13	OPERATION ROAD - 2 (TO SADDLE DAM)	3,609,514.87	
	SUB TOTAL A (PART 1 TO PART 24)	**226,918,413.22**	
B	**Engineering Cost (11.5 % of A)**	**26,095,617.52**	
	Detailed design and construction supervision (10 %)	22,691,841.32	
	Environmental Monitoring Unit and Training Skilled Development to Local People (1.5 %)	3,403,776.20	
	TOTAL	**253,014,030.75**	
	CONTINGENCIES 15%	**37,952,104.61**	
	Total	**290,966,135.36**	
	VAT 13 %	**37,825,597.60**	
	GRAND TOTAL	**328,791,732.95**	

In words: (Three hundred twenty eight million seven hundred ninity one thousand seven hundred thirty three only)

Source: JICA Study Team

Supporting Report H-2: Procurement Cost

Procurement Cost of Equipment and the Renewal

Items		Rs/unit	Remarks	Procurement Units					Procurement Cost (Rs. 000)				
				Initial	Renewal				Initial	Renewal			Post-closure
				2009/10	2013/14	2018/19	2023/24	2029/30	2009/10	2013/14	2018/19	2023/24	2029/30
Light Equipment and Machinery	Car wash machine	100,000		2	2	2	2		200	200	200	200	0
	Blower	1,000,000		8		8		8	8,000	0	8,000	0	8,000
	Re-circulation pump	653,040		2		2		2	1,306	0	1,306	0	1,306
	Conveying pump(For Landfill)	653,040		2		2		2	1,306	0	1,306	0	1,306
	Conveying pump(For sedimentation)	489,780		2		2		2	980	0	980	0	980
	Sub-total			16	2	16	2	14	11,792	200	11,792	200	11,592
	Spare Parts		5%						590	10	590	10	580
	Miscellaneous		8%						991	17	991	17	974
	VAT		13%						1,738	29	1,738	29	1,709
	Total								15,110	256	15,110	256	14,854
Heavy Equipment and Vehicles	Compactor	26,666,666	35t	1		1			26,667	0	26,667	0	0
	Bulldozer	16,400,000	21t	1		2			16,400	0	32,800	0	0
	Excavator	7,600,000	0.7m3	2		2			15,200	0	15,200	0	0
	Water tanker	3,400,000	6t-10t	1		1			3,400	0	3,400	0	0
	Wheel loader	11,266,666	3.5m3	1		1			11,267	0	11,267	0	0
	Dump Truck	5,066,666	10t	2		2			10,133	0	10,133	0	0
	Sub-total			8		9			83,067	0	99,467	0	0
	Spare Parts		5%						4,153	0	4,973	0	0
	Miscellaneous		8%						6,978	0	8,355	0	0
	VAT		13%						12,246	0	14,663	0	0
	Total								106,443	0	127,459	0	11,592
Grand Total									121,553	256	142,569	256	26,446

Supporting Report H-3: O & M Cost

O & M Cost

No.	Item	1 2009/10	2 2010/11	3 2011/12	4 2012/13	5 2013/14	6 2014/15	7 2015/16	8 2016/17	9 2017/18	10 2018/19
1	Staff										
	a. Manager	287.3	287.3	287.3	287.3	287.3	287.3	287.3	287.3	287.3	287.3
	b. Engineer										
	① Civil	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9
	② Facility(electrical/mechanical)	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9
	c. Clerk/ Secretary	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2
	d. Weighbridge operator	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1
	e. Heavy Equipment operator										
	(1) For landfilling										
	① Compactor	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1
	② Bulldozer	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1
	③ Excavator	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1
	④ Water tanker	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1
	(2) For soil taking										
	① Wheel loader	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1
	② Excavator	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1
	③ Dump Truck	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1
	f. Mechanic	205.2	205.2	205.2	205.2	205.2	205.2	205.2	205.2	205.2	205.2
	g. Workers(Dumping platform instructor	396.7	396.7	396.7	396.7	396.7	396.7	396.7	396.7	396.7	396.7
	h. Guard	198.4	198.4	198.4	198.4	198.4	198.4	198.4	198.4	198.4	198.4
	Sub-total Staff	2,834.0	2,834.0	2,834.0	2,834.0	2,834.0	2,834.0	2,834.0	2,834.0	2,834.0	2,834.0
2	Fuel										
	a. Compactor	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0
	b. Bulldozer	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0	1,440.0
	c. Wheel loader	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0
	d. Excavator	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0
	e. Dump Truck	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0
	f. Water tanker	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0
	g. Car wash machine	211.8	211.8	211.8	211.8	211.8	211.8	211.8	211.8	211.8	211.8
	h.Blower	959.9	959.9	959.9	959.9	959.9	959.9	959.9	959.9	959.9	959.9
	i.Re-circulation pump	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9
	j.Conveying pump(For Landfill)	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9
	Conveying pump(For sedimentation)	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0
	k.Office	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
	Sub-total Fuel	14,027.5	14,027.5	14,027.5	14,027.5	14,027.5	14,027.5	14,027.5	14,027.5	14,027.5	14,027.5
3	Heavy Equipment Maint/Repair										
	a. Compactor	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3
	b. Bulldozer	820.0	820.0	820.0	820.0	820.0	820.0	820.0	820.0	820.0	820.0
	c. Wheel loader	563.3	563.3	563.3	563.3	563.3	563.3	563.3	563.3	563.3	563.3
	d. Excavator	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0
	e. Dump Truck	506.7	506.7	506.7	506.7	506.7	506.7	506.7	506.7	506.7	506.7
	f. Water tanker	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0
	g. Weighbridge	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	h. Car wash machine	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	i.Blower	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
	j.Re-circulation pump	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3
	k.Conveying pump(For Landfill)	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3
	Conveying pump(For sedimentation)	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
	Sub-total Heavy Equipment Maint/Re	4,462.9	4,462.9	4,462.9	4,462.9	4,462.9	4,462.9	4,462.9	4,462.9	4,462.9	4,462.9
4	Miscellaneous										
	Sum (1.～3.)×10%	2,132.0	2,132.0	2,132.0	2,132.0	2,132.0	2,132.0	2,132.0	2,132.0	2,132.0	2,132.0
5	Civil work										
	Maintenance										
	a. Rainwater drainage										
	① Temporary drainage	698.0	0.0	767.8	837.6	907.4	0.0	977.2	0.0	907.4	837.6
	② Permanent drainage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	671.6	488.4
	b. Working road	107.1	0.0	107.1	122.4	122.4	0.0	137.7	0.0	137.7	137.7
	c. Gas removal pipe(Vertical)	1,150.4	0.0	1,150.4	1,481.1	1,481.1	0.0	1,811.9	0.0	1,811.9	1,524.3
	d. Leachate collection pipe										
	① Main pipe	0.0	0.0	0.0	0.0	2,100.0	0.0	0.0	0.0	0.0	0.0
	② Branch pipe	0.0	0.0	0.0	0.0	3,487.0	0.0	0.0	0.0	0.0	0.0
	e.Turfing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,176.5	724.0
	Construction of Phase-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sub-total Civil work	1,955.5	0.0	2,025.3	2,441.1	8,097.9	0.0	2,926.8	0.0	4,705.0	3,712.0
6	Sub-total (1.～5.)	25,412.0	23,456.5	25,481.8	25,897.6	31,554.4	23,456.5	26,383.2	23,456.5	28,161.5	27,168.4
7	VAT										
	6×13%	254.0	0.0	263.0	317.0	1,052.0	0.0	380.0	0.0	611.0	482.0
8	**Total**	25,666.0	23,456.5	25,744.8	26,214.6	32,606.4	23,456.5	26,763.2	23,456.5	28,772.5	27,650.4

No.	Item	11 2019/20	12 2020/21	13 2021/22	14 2022/23	15 2023/24	16 2024/25	17 2025/26	18 2026/27	19 2027/28	20 2028/29	Total	Post-closure Maintenance 2029/30～2038/39	
1	Staff													
	a. Manager	287.3	287.3	287.3	287.3	287.3	287.3	287.3	287.3	287.3	287.3			
	b. Engineer													
	① Civil	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9		2,138.6	1.0
	② Facility(electrical/mechanical)	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9	213.9		2,138.6	1.0
	c. Clerk/ Secretary	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2			
	d. Weighbridge operator	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1			
	e. Heavy Equipment operator													
	(1) For landfilling													
	① Compactor	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1			
	② Bulldozer	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1			
	③ Excavator	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1			
	④ Water tanker	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1			
	(2) For soil taking													
	① Wheel loader	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1			
	② Excavator	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1	134.1			
	③ Dump Truck	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1	268.1			
	f. Mechanic	205.2	205.2	205.2	205.2	205.2	205.2	205.2	205.2	205.2	205.2			
	g. Workers(Dumping platform instructor	396.7	396.7	396.7	396.7	396.7	396.7	396.7	396.7	396.7	396.7			
	h. Guard	198.4	198.4	198.4	198.4	198.4	198.4	198.4	198.4	198.4	198.4			
	Sub-total Staff	3,102.2	3,102.2	3,102.2	3,102.2	3,102.2	3,102.2	3,102.2	3,102.2	3,102.2	3,102.2	59,362.1	4,277.3	
2	Fuel													
	a. Compactor	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0	3,600.0			
	b. Bulldozer	2,880.0	2,880.0	2,880.0	2,880.0	2,880.0	2,880.0	2,880.0	2,880.0	2,880.0	2,880.0			
	c. Wheel loader	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0	2,448.0			
	d. Excavator	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0	2,592.0			
	e. Dump Truck	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0	1,296.0			
	f. Water tanker	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0			
	g. Car wash machine	211.8	211.8	211.8	211.8	211.8	211.8	211.8	211.8	211.8	211.8			
	h.Blower	959.9	959.9	959.9	959.9	959.9	959.9	959.9	959.9	959.9	959.9		4,853.3	
	i.Re-circulation pump	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9		2,399.6	
	j.Conveying pump(For Landfill)	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9	479.9		2,399.6	
	Conveying pump(For sedimentation)	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0			
	k.Office	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0			
	Sub-total Fuel	15,467.5	15,467.5	15,467.5	15,467.5	15,467.5	15,467.5	15,467.5	15,467.5	15,467.5	15,467.5	294,949.9	9,652.5	
3	Heavy Equipment Maint/Repair													
	a. Compactor	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3	1,333.3			
	b. Bulldozer	1,640.0	1,640.0	1,640.0	1,640.0	1,640.0	1,640.0	1,640.0	1,640.0	1,640.0	1,640.0			
	c. Wheel loader	563.3	563.3	563.3	563.3	563.3	563.3	563.3	563.3	563.3	563.3			
	d. Excavator	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0			
	e. Dump Truck	506.7	506.7	506.7	506.7	506.7	506.7	506.7	506.7	506.7	506.7			
	f. Water tanker	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0	170.0			
	g. Weighbridge	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0			
	h. Car wash machine	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0			
	i.Blower	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0		4,000.0	
	j.Re-circulation pump	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3		653.0	
	k.Conveying pump(For Landfill)	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3		653.0	
	Conveying pump(For sedimentation)	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0			
	Sub-total Heavy Equipment Maint/Re	5,382.9	5,382.9	5,382.9	5,382.9	5,382.9	5,382.9	5,382.9	5,382.9	5,382.9	5,382.9	98,458.4	5,306.1	
4	Miscellaneous													
	Sum (1.～3.)×10%	2,395.0	2,395.0	2,395.0	2,395.0	2,395.0	2,395.0	2,395.0	2,395.0	2,395.0	2,395.0	45,270.0	1,923.0	
5	Civil work													
	Maintenance													
	a. Rainwater drainage													
	① Temporary drainage	837.6	837.6	837.6	837.6	837.6	837.6	1,465.8	1,326.2	1,326.2	2,792.0			
	② Permanent drainage	549.5	549.5	610.5	671.6	671.6	671.6	1,282.1	1,221.0	1,221.0	3,296.7			
	b. Working road	137.7	137.7	137.7	137.7	137.7	137.7	137.7	137.7	137.7	137.7			
	c. Gas removal pipe(Vertical)	1,524.3	1,438.0	1,438.0	1,294.2	1,294.2	1,150.4	2,157.0	1,869.4	1,869.4	3,738.8			
	d. Leachate collection pipe													
	① Main pipe	2,100.0	0.0	0.0	0.0	1,575.0	0.0	0.0	1,050.0	0.0	525.0			
	② Branch pipe	3,487.0	0.0	0.0	0.0	2,853.0	0.0	0.0	1,585.0	0.0	792.5			
	e.Turfing	905.0	905.0	905.0	995.5	1,086.0	1,176.5	2,172.0	2,172.0	2,172.0	8,145.0			
	Construction of Phase-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	Sub-total Civil work	9,541.0	3,867.8	3,928.8	3,936.6	8,455.1	3,973.8	7,214.6	9,361.3	6,726.3	19,427.7	102,296.5		
6	Sub-total (1.～5.)	35,888.6	30,215.3	30,276.4	30,284.1	34,802.6	30,321.3	33,562.1	35,708.9	33,073.9	45,775.3	600,336.8	21,158.9	
7	VAT													
	6×13%	1,240.0	502.0	510.0	511.0	1,099.0	516.0	937.0	1,216.0	874.0	2,525.0	13,289.0		
8	**Total**	37,128.6	30,717.3	30,786.4	30,795.1	35,901.6	30,837.3	34,499.1	36,924.9	33,947.9	48,300.3	613,625.8	21,158.9	

Supporting Report H-4: Projected LDF and Property Tax

(1) Projected Local Development Fee (LDF) until Year 2013

LDF will fade out gradually (practically, year-wise and industrial sector-wise abolishment according to the Harmonized System (HS) codes) by December 2013. However, Government has not transmitted municipalities any information on year-wise predicted amount of LDF until year 2013.

Consequently, the Study Team projects the year-wise LDF amount of each municipality until year 2013 according to the following assumptions by referring the information from Government. The assumption also includes alternatives to LDF that is to be studied by Government to relieve the municipalities.

< Assumptions to project the year-wise LDF >

Items	05/06-07/08	08/09-10/11	11/12-13/14
LDF to municipality	To continue the same amount	90% on previous year for each year	75% on previous year for each year
Alternatives to LDF (to make up for dropped amount)	none	Half on dropped amount of LDF compared with 2004/05 amount	

Projected LDF and alternatives of each municipality is summarized in the following table.

Municipality	Items	05/06	08/09	09/10	10/11	11/12	12/13	13/14	14/15
KMC	LDF	237.5	213.8	192.4	173.1	129.9	86.6	43.3	0.0
	Alternatives	0	11.9	22.6	32.2	53.8	75.5	97.1	118.8
	Total	237.5	225.6	214.9	205.3	183.7	162.0	140.4	118.8
	Change	**0**	**-11.9**	**-22.6**	**-32.2**	**-53.8**	**-75.5**	**-97.1**	**-118.8**
LSMC	LDF	52.4	47.2	42.4	38.2	28.6	19.1	9.5	0.0
	Alternatives	0	2.6	5.0	7.1	11.9	16.7	21.4	26.2
	Total	52.4	49.8	47.4	45.3	40.5	35.7	31.0	26.2
	Change	**0**	**-2.6**	**-5.0**	**-7.1**	**-11.9**	**-16.7**	**-21.4**	**-26.2**
KRM	LDF	11.9	10.7	9.6	8.7	6.5	4.3	2.2	0.0
	Alternatives	0	0.6	1.1	1.6	2.7	3.8	4.9	6.0
	Total	11.9	11.3	10.8	10.3	9.2	8.1	7.0	6.0
	Change	**0**	**-0.6**	**-1.1**	**-1.6**	**-2.7**	**-3.8**	**-4.9**	**-6.0**

Note: 1) Half of the dropped amount compared to FY 2004/05 LDF is expected as alternatives. 2) Change means difference of amount between FY 2004/05 and respective FY.

Source: JICA Study Team

(2) Financial Resources necessary to be generated by municipalities themselves

Judging from the above LDF and actual financial capacity of municipalities, it is difficult to expect municipalities to cover entire SWM Costs. So, in order to accomplish the Project smoothly, it has to be done by municipalities themselves to develop and diverse the source of funds as follows:

1. To enhance revenue generation capability especially on Property Tax

2. To utilize the Reserved Fund that is currently only Government tool of financial support to municipality
3. Other Alternatives to be studied
   a. To introduce Public Private Partnership on SWM to reduce the SWM cost
   b. To create new charges on SWM services

1) Enhancement of Revenue Generation Capability

LDF is crucial concern for every municipality that will end by December 2013. Taking it into account, Government has shifted the property tax, which was entirely Government revenue, to municipalities since FY 2000/01. The property tax is considered as the optimum revenue mobilization because it is expected to increase in line with growing urbanization and population. However, in reality, the municipalities have not reformed or improved the system of the property tax enough to catch up with growing urbanization, increasing population and demand of municipality services from the community. Accordingly, now, it is the most crucial matter for every municipality to strengthen it to make up for the downward LDF.

KMC and LSMC have already started to implement the revenue enhancement measures envisaging the financial constraint in future. On the other hand, KRM has not yet started their own enhancement measures, so that KRM has to study them soonest possible.

< Preliminary Projection of year-wise Property Tax >

Preliminarily, the Study Team projected the year-wise property tax amount of each municipality until target year of 2014/15 applying the following assumptions based on the information from municipalities as shown in the following table.

Municipality	Base Data	Base Year	Projection		
		2004/05	2005/06	2009/10	2014/15
KMC	Person/residential building	8.2	8.2	8.2	8.2
	No. of residential building	90,000	93,821	109,104	128,208
	% of residential buildings that pays property tax	44%	54%	**90%**	**90%**
	Tax rate/ residential building	Rp.3,250	Rp.3,250	Rp.3,250	Rp.3,250
LSMC	Person/residential building	6.9	6.9	6.9	6.9
	No. of residential building	25,822	26,973	31,576	37,330
	% of residential buildings that pays property tax	32%	44%	**90%**	**90%**
	Tax rate/ residential building	Rp.1,810	Rp.1,810	Rp.1,810	Rp.1,810
KRM	Person/residential building	6.5	6.5	6.5	6.5
	No. of residential building	6,726	6,896	7,576	8,426
	% of residential buildings that pays property tax	20%	34%	**90%**	**90%**
	Tax rate/ residential building	Rs.740	Rs.740	Rs.740	Rs.740

Source: JICA Study Team

Note: Following Criteria is applied for assumptions of the table:

Items	Base Year (2004/05)		Projection
	KMC	Other municipalities	
1. Persons/residential building	Calculated from household size and number of residential buildings		Same as base year's data
2. Number. of residential building	information from KMC	1.5 households/residential building	To consider population growth
3. % of house buildings that paid property tax	information from KMC, currently 44 %	assumed based on the actual amount collected, 32 % in LSMC, and 20 % in KRM, BKM and TMT	To set up target of 90 % until 2009/10
4. Tax rate/residential building	calculated from data of actual collected amount and assumed number of residential buildings that paid property tax,		Same as base year's data

Thus, future property tax of each municipality until the target year 2014/15 is projected and summarized in the following table.

Municipality	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
KMC	163.3	198.9	236.7	276.8	319.1	330.3	341.5	352.7	363.8	375.0
Change	+33.3	+68.9	+106.7	+146.8	+189.1	+200.3	+211.5	+222.7	+233.8	+245.0
LSMC	21.3	28.1	35.4	43.2	51.4	53.3	55.2	57.1	58.9	60.8
Change	+6.3	+13.1	+20.4	++28.2	+36.4	+38.3	+40.2	+42.1	+43.9	+45.8
KRM	1.7	2.5	3.3	4.2	5.0	5.2	5.3	5.4	5.5	5.6
Change	+0.7	+1.5	+2.3	+3.2	+4.0	+4.2	+4.3	+4.4	+4.5	+4.6

Note: change means difference of amount between FY 2004/05 and respective FY.

Source: JICA Study Team

Supporting Report H-5: Actual Fiscal Balance of Last 5 Years

1. Kathmandu Metropolitan City

(million Rs)

Items			2000/01 (2057/58)	2001/02 (2058/59)	2002/03 (2059/60)	2003/04 (2060/61)	2004/05 (2061/62)	2005/06 (2062/63)
			Actual	Actual	Actual	Actual	Actual	Budget
Opening Balance			61.8	0	0	0	-	0
Revenue	Tax	Local Develop. Fee	235.1	266.2	239.2	237.5	237.6	240.0
		Property Tax	0.3	108.0	71.2	62.7	126.7	147.5
		Professional Tax	10.1	16.1	22.4	18.1	21.8	22.5
		Others	52.7	11.6	10.7	0.4	8.0	19.5
		Total	298.2	401.9	343.5	318.7	394.1	429.5
	Fees /Charges & Others	Services Fee	13.5	15.5	33.2	43.5	21.4	42.0
		Building Permit	57.6	56.4	113.8	122.7	113.1	130.0
		Others	24.9	42.9	38.6	41.0	92.1	273.5
		Total	96.0	114.8	185.6	207.2	226.7	445.5
	Grants		12.6	14.0	1.8	27.6	19.3	647.9
	Debt		0	0	0	0	0	0
	Total of Revenue		406.8	530.7	530.9	553.5	640.1	1,522.9
Expen -diture	Current	Personnel Expenses	137.8	148.2	150.7	150.6	107.7	115.2
		Repair/Maintenance	7.9	6.8	16.0	136.2	157.3	196.7
		Fuel	18.7	20.6	21.3			
		Others	47.3	67.9	49.6			
		Total	211.7	243.5	237.6	286.8	265.0	312.0
	Social Prog./Infrastructure Services*		14.8	11.8	100.7	266.3	310.3	1,124.5
	Capital	Vehicles	5.9	0.3	-	2.7	1.2	1.5
		Machinery & Equip.	1.2	0.4	0.3	13.6	0.8	58.9
		Land/Building	29.4	35.1	4.4	4.0	0	5.0
		Other Development	112.9	193.6	0	0	0	0
		Others	0.3	1.5	0.1	6.1	6.1	21.1
		Total	149.7	230.9	4.8	26.4	8.1	86.4
	Debt Payment		30.4	29.4	30.8	0	0	0
	Total of Expenditure		406.6	515.6	373.9	579.5	583.5	1,522.9
Closing Balance			62.0	15.1	157.0	-26.0	56.6	0

Note: 1) Opening balance is not equal to previous closing balance because of inconsistency between budget balance and outstanding bank account due to account system**,** 2) * Item of Infrastructure Services is added as a new category from 2002/03.

Source: Information from UDLE of GTZ and Budget Report of KMC

2. Lalitpur Sub-Metropolitan City

(million Rs)

Items			2000/01 (2057/58)	2001/02 (2058/59)	2002/03 (2059/60)	2003/04 (2060/61)	2004/05 (2061/62)	2005/06 (2062/63)
			Actual	Actual	Actual	Actual	Actual	Budget
Opening Balance			19.8	29.6	0	0	0	
Revenue	Tax	Local Develop. Fee	52.4	56.8	52.4	52.4	52.4	52.4
		Property Tax	3.8	20.5	10.4	11.7	11.1	13.8
		Professional Tax	1.4	2.4	2.2	2.2	6.2	10.2
		Others	3.7	3.0	2.2	2.3		
		Total	61.3	82.7	67.2	68.6	69.7	76.4
	Fees /Charges & Others	Services Fee	20.6	10.3	7.5	12.9	8.1	21.2
		Building Permit	8.6	15.3	16.6	15.8	16.5	20.0
		Others	6.3	9.8	9.0	16.1	12.8	20.5
		Total	35.5	35.4	33.1	44.8	37.3	61.7
	Grants		6.8	0.8	2.0	2.1	1.4	25.3
	Debt		0	0	0	0	0	20.0
	Total of Revenue		103.6	118.9	102.3	115.5	108.4	183.4
Expen -diture	Current	Personnel Expenses	36.1	37.9	39.1	44.2	39.1	55.6
		Repair/Maintenance	0.6	0.8	1.0	1.0	1.1	2.4
		Fuel	4.4	4.0	4.6	4.6	6.4	9.2
		Others	13.7	22.7	12.5	12.6	7.1	12.6
		Total	54.8	65.5	57.3	62.4	53.7	79.8
	Social Program		3.2	2.1	0.8	5.7	6.6	12.4
	Capital	Vehicles	0	0	0.8	1.7	0.2	0.2
		Machinery & Equip.	1.0	0	0.8	1.5	1.1	2.0
		Land/Building	0	0.6	0.1	0	0.4	6.1
		Other Development	32.1	53.1	36.0	49.0	25.8	91.1
		Others	2.3	2.1	0.4	0.4	0.2	2.1
		Total	35.4	55.8	38.1	52.7	27.7	101.5
	Debt Payment		1.1	2.1	0	0.2	0.1	3.2
	Total of Expenditure		94.5	125.5	96.2	121.0	88.0	196.9
Closing Balance			28.9	23.0	6.1	-5.5	20.0	0

Note: Opening balance is not equal to previous closing balance because of inconsistency between budget balance and outstanding bank account due to account system

Source: Information from UDLE of GTZ and Budget Report of LSMC

3. Kirtipur Municipality

(million Rs)

Items			2000/01 (2057/58)	2001/02 (2058/59)	2002/03 (2059/60)	2003/04 (2060/61)	2004/05 (2061/62)	2005/06 (2062/63)
			Actual	Actual	Actual	Actual	Actual	Budget
Opening Balance			-	0.4	0.2	3.6	0.5	10.1
Revenue	Tax	Local Develop. Fee	11.4	13.9	11.9	11.9	11.9	11.9
		Property Tax	0	1.0	1.0	1.0	1.6	1.8
		Professional Tax	0.2	0.3	0.2	0.2	1.4	1.8
		Others	1.8	0.8	0.8	0.9		
		Total	13.4	16.0	13.9	14.0	15.0	15.6
	Fees /Charges & Others	Services Fee	0.1	0.1	0.2	0.3	0.1	0.7
		Building Permit	0	0.6	0.8	2.2	3.3	3.5
		Others	1.0	0.6	0.8	1.1	1.5	1.6
		Total	1.1	1.3	1.8	3.6	5.0	5.8
	Grants		2.2	3.1	1.7	6.6	5.3	14.3
	Debt		0	0	0	0	0	0
Total of Revenue			16.7	20.4	17.4	24.2	25.2	35.6
Expen -diture	Current	Personnel Expenses	4.1	4.4	3.6	4.8	5.6	6.9
		Repair/Maintenance	0.3	0.8	0.3	0.3	0.3	0.4
		Fuel	0.4	0.8	0.3	0.6	0.6	0.6
		Others	1.9	2.1	1.1	1.6	1.2	2.2
		Total	6.7	8.1	5.3	7.3	7.7	10.1
	Social Program		1.7	2.3	1.6	0.7	0.5	0.9
	Capital	Vehicles	0.7	0	0.1	0	0	0
		Machinery & Equip.	0.1	0	0	0.1	0	0.1
		Land/Building	0.5	0.1	0	0	0	5.0
		Other Development	6.9	10.0	5.3	10.8	11.2	27.4
		Others	0	0	0	4.4	0.1	2.2
		Total	8.2	10.1	5.4	15.3	11.3	34.8
	Debt Payment		0	0	0	0	0	0
Total of Expenditure			16.6	20.5	12.3	23.3	19.5	45.8
Closing Balance			0.1	0.3	5.3	4.5	6.2	0

Note: Opening balance is not equal to previous closing balance because of inconsistency between budget balance and outstanding bank account due to account system

Source: Information from UDLE of GTZ and Budget Report of KRM

Supporting Report I

Municipal Data for Waste Collection/Transportation in KMC and LSMC

I-1 Inventory of KMC equipment for Solid Waste Management

Vehicle List- KMC

Vehicles used for SWM

S.N	Vehicle Equipment/ Type	Counry of Origin	Capacity (m^3)	Total no of Units	Purchase/Usage Year	Donated By/ Purchased	Remarks
1	**For Primary Colletion**						
1.1	Hydraulic Tipper (Mitsubishi Canter)	Indian	3.00	15	1993	Donated by Government of India	
1.2	Dumper Placer (DCM Toyota)	Indian	4.00	8	1994	Donated by Government of India	
1.3	Dumper Placer(Askok Leyland)	Indian	6.00	4	1994	Donated by Government of India	
1.4	Dumper Placer (Tata)	Indian	4.50	3	1988	Donated by Government of India	1 unit not working
1.5	Multi-compactor(Tata)	Indian	6.00	1	1997	Purchased by KMC	
1.6	Tractor	Chinese	1.70	37	1988	Purchased by KMC	
1.7	Multi-compactor	Japanese	4.00	1	-	Donated by Government of Japan	
1.8	Hydraulic Tipper (Swraj Mazda)	Indian	4.50	10	2002	Purchased by KMC	
1.9	Multi-Compactor	Japanese	4.00	2	2002	Donated by Government of Japan	
				81			
2	**For Secondary Transpotation**						
2.1	Multi-Compactor (Ashok Leyland)	Indian	14.00	7	1994	Donated by Government of India	
2.2	Roll-off Tipper (M.Benz)	German	14.00	2	1988	Donated by GTZ	1 unit not working
2.3	Back -Hoe JCB Loader	Indian	0.75	2	1994	Donated by Government of India	
2.4	Shovel Loader	German	0.75	1	-	Donated by GTZ	
2.5	Excavator	German	0.25	1	1986	Donated by GTZ	
2.6	Shovel Loader	Belarus	0.75	3	2003	Purchased by KMC	
2.7	Bobcat	Belarus		2	2003	Purchased by KMC	
2.8	Multi Compactors(Ashok Leyland)	Indian	15.00	17	2005	Donated by Government of Japan	
				35			
3	**For Operation in Landfill Site**						
3.1	Chain Dozer			2	1981	Donated by GTZ	
3.2	Sheep-footed Compactor			1	1988	Donated by GTZ	
3.3	Excavator	Korean	0.25	1	2003	Purchased by KMC	
				4			
	Total			**120**			
S.N	Vehicle Equipment/ Type	Counry of Origin	Capacity(m	Total no of U	Purchase/Usage	Donated By/ Purchased	Remarks
1	**Sewer Cleaning**						
1.1	Jetting Vehicles (DCM Toyata)	Indian	3.00	4	1994	Donated by Government of India	
1.2	Suction Vehicles (DCM Toyata)	Indian	3.00	4	1994	Donated by Government of India	
1.3	Jetting & Suction Vehicle(Ashok Leyland)	Indian	6.00	2	1994	Donated by Government of India	
1.4	Suction Vehicles (Ashok Leyland)	Indian	6.00	1	1988	Donated by Government of India	
1.5	Jetting Vehicles (Ashok Leyland)	Indian	6.00	1	1998	Donated by Government of India	
1.6	Water Tanker (Ashok Leyland)	Indian	9.00	2	1994	Donated by Government of India	
				14			

I-2 Current Container Locations in KMC

Locations of Skip Containers
Kathmandu Metropolitan City

S.N	Location
Private Containers	
1	Solatee Hotel
2	Teaching Hospital
3	Galaxy School
4	Police Headquater
5	Royal Palace
6	Birendra Police Hospital
7	New Buspark
8	British Embassay
9	Dairy Development Planning
10	Prasuti Griha
11	Health Department, Teku
12	Birendra Army Hospital
13	Sahid Gangalal Hospital
14	Kanti Children's Hospital
15	Gauri Nagar tole Sudhar Samiti
16	Chinese Embassay
17	Nepal Medical College
18	Russian Embassay
19	Nepal rastrya Bank , Baluwatar
20	Dairy Development Corporation
21	Agricultural Development Bank
22	Salt Trading Ltd
23	Nepal Rastrya Bank, Thapathali
25	Chest Hospital
26	Nursing Campus
27	Nepal Bank Lltd
28	Trichandra Military Hospital
29	Nepal Carpet Enterprises(Budhanilkhanta VDC)
30	Bijeshwori Awas Griha
31	Tax Office
32	Rajkiya Pragya Pratisthan
33	Tilganga Eye Hospital
34	Kathmandu Solid Waste Management Services.
35	Armed Police Force office(Ichhangu VDC)
Public Containers	
1	Makhan
2	Nirmal Niwas
3	Gaurighat A, B
4	Bayis Dhara
5	Indian Embassay
6	Lainchowr
7	Singa Durbar
8	Royal Palace.

I-3 Inventory of KMC equipment for Solid Waste Management

Present Solid Waste Collection Routes
Kathmandu Metropolitan City

SN	Routes	Vehicle No.	Vehicle Type
1	Teku line,Kidgal, Tripurehwor, Around Anamnagar	4134	Tipper
2	Nagsthan, Ratnapark, Around Sundhara, Bhotahiti Jamal, Old Buspark, Around Bhadra Kali	4128	Tipper
3	Jamal,KesharMahal, Lainchowr,Lazimpat,Samakhushi,Ward 2 , maharajgunj, Prime Minister Quarter, Around Royal Palace	4129	Ripper
4	Tripureshwor, Thapathali,Maitighar, babarMahal,Tinkune, Airport	3354	Tipper
5	KMC Ward No 3	2796&508	Tipper & Tractor
6	KMC Ward No 4	2795;515;516	Tipper & Tractor
7	KMC Ward No 5	2791;541,2794	Tipper & Tractor
8	KMC Ward No 6	2793;517	Tipper & Tractor
9	KMC Ward No 7	4136	Tipper
10	KMC Ward No 9	2801	Tipper
11	KMC Ward No 10	2790	Tipper
12	KMC Ward No 11	525	Tractor
13	KMC Ward No 15	4135	Tipper
14	KMC Ward No 16	4137;551	Tipper & Tractor
15	KMC Ward No 17	2792;532	Tipper & Tractor
16	KMC Ward No 19	2797	Tipper
17	KMC Ward No 21	509	Tractor
18	KMC Ward No 22	4132	Tipper
19	KMC Ward No 23	536	Tractor
20	KMC Ward No 26	524	Tractor
21	KMC Ward No 34	4130	Tipper
22	KMC Ward No 35	4133	Tipper
23	KMC Ward No 28	3232	Tipper
24	KMC Ward No 30	515	Tractor
25	Sinamangal, Old Baneshwor, Maitidevi, Dillibazar, Bagbazar.	3216	Tipper
26	KMC ward 19, Bhimsensthan, Kastmandap	527	Tractor
27	Balkhu	512	Tractor
28	Trichandra College	511	Tractor
29	Special A (Teku Line, Khitel Tripureshwor, Thapathali,, Maitighar, BabbarMahal, Naya Baneshwor, Tinkune,Airport, tilganga, Gaushala Battisputali, Bagbazar, Ghantaghar, Airport, Dillibazar, Lainchaur, Lazimpat, Maharajgunj, Baluwatar, Gauridhara, Around Royal Palace, Sahid gate)	4476	Tipper

I-4 Inventory of LCMC equipment for Waste Collection

Vehicle List- LSMC

Vehicles used for SWM

S.N	Vehicle Equipment/ Type	Counry of Origin	Capacity (m^3)	Working Units	Purchase/Usage Year	Donated By/ Purchased
1	**For Primary Collection**					
1.1	Dumper Placer(Isuzu)	German	7.5	1 unit working		Donated by GTZ
1.2	Dumper Placer(Eicher)	Indian	4.5	1 unit working		Donated by GTZ
1.3	Tipper (Eicher)	Indian	3.5	11 units working		Donated by Government of India
1.4	Tractor(Eicher)	Indian	2.2	2 units working		Donated by Government of India
2	**For Secondary Transpotation**					
2.1	Multi Compactor(Ashok Leylnd)	Indian	15	4	2005	Donated by Government of Japan.

I-5 Current Container Locations in LSMC

Locations of Skip Containers
Lalitpur Sub-Metropolitan City

S.N	Location
Private Containers	
1	Patan Hospital
2	SATA Office, Jawalakhel
3	B & B Hospital
4	Wai Wai Noodles Factory
Public Containers	
1	Bagmati bridge (used by NEPCEMAC)
2	Ram Mandir, Sanepa
3	Naya Basti(used by WEPCO)
4	Pulchowk, Behind Institute of Engineering
5	Jwagal
6	Tashikhel
7	Dhalau Factory
8	Ministry of Local Development
9	Minister Quarter, Hariharbhawan

I-6 Inventory of KMC equipment for Solid Waste Management

Present Collection Routes
Lalitpur Sub Metropolitan City

S.No	Vehicle No.	Vehicle Type	Code No.	Routes
1	790	Mini Container	1	Balkumari, Gwarko, Satdobato
			2	Ward 14, Buddhanagar
			3	Ward 13, Kusunti
			4	Tute pani, Nakhipot
			5	Tibetan Camp
			6	Afternoon route
2	791	Mini Container	7	Mahapal Ikhalakhu,Iti
			8	Nayagaan, Taan Dhoka, Kwayawahi
			9	Patan Hospital, Dakchhhinkali
			10	Behind Rajdal
			11	Pulchowk, Inar, Kupondole
			12	Chhaya Bahal, Oasis Hotel
3	796	Mini Container	13	Jhatpole, Kumbheshwor
			14	Chalkhhu,Pim bahal,Mikha bahal
			15	Chakupat,Ikha chhen, taapaahiti
			16	Nya tole, Alko
4	797	Mini Container	17	Mangal bazar, Mahapal,Na tole.
			18	Nag bahal
			19	Lagankhel,Prayag pokahri, Sinchha hiti
			20	Ward 6, Gwarko
5	798	Tipper	21	Pulchowk, Damkal, Bihar
			22	Sanepa, Ram mandir
			23	Thado Dunga, Dhobikhola, Majhi khola
			24	Ram mandir, Gusingal
			25	Sanepa, Kiran Bhawan , Bhakundole
5	799	Tipper	26	Balkumari , Bhol dokha
			27	Bhol; Ganeshstan, Bholkhel
			28	Su bahal,Yol,Chhyasal
			29	Purnachandi,Bagtu
			30	Manbhawan,Dakchhinkali, Thasikhel
			31	Satdo bato, Thasikhel
6	800	Tipper	32	, Lagankhel,Iti
			33	Jawakhel, Kumari pati.
			34	Agnikhal
			35	Ward 13, Kusunti, Zoo
7	801	Tipper	36	Pichhen, Pilachhen
			37	Rice mill ,Purna chandi
			38	Mangal bazar, Saugal tole
			39	Gwarko Sundhara
8	802	Tipper	40	Lukhushi tole
			41	Thainna , Prayag Pokhari
			42	Chakra bahil tole
			43	Lagankhel , Iti, Tangal tole
			44	Mangal bazar, Tangabahil,Haugal
			45	Sundhara, Okubahal
9	803	Tipper	46	Gairaidhara,Shwatha, Kobahal
			47	Krishna galli, Patandhoka
			48	Ashok hall,Nakbahil,Dhalavhha
			49	Kwalakhu, Patko,Kumbheshwor
			50	Gaan hiti, Sankhamul
10	804	Tipper	51	B & B Hospital
			52	Jwagal
			53	WEPCO no 2
			54	Jhamshikhel
			55	SATA
11	349	Big container	56	Dhalaut Office
			57	Naya basti
			58	Taalchhikhel
			59	Minister Quarter(Harhar Bhawan)
			60	WEPCO women Environment
			61	Ministry of Local Development
12	1172	Tractor	62	Saanko, Chhanki
			63	Chapat tole
			64	Subahal,Bhinchhe bahal
			65	Inamohal
			66	Om bahal
			67	Kuti Saugal
			68	Yung bahal
			69	Ward 11, Tilako
			70	Pichhen
			71	Khapilachhen
			72	Bhaindo Lachhi
13	1175	Tractor	73	Mahila Sauchlaya
			74	Dupat
			75	Natole,Machagal, Nyagaan
			76	Dhaugal Bazar
14	795	Dumper	77	Balkumari , Satdo bato
			78	Buddhanagar
			79	Ward 13, Kusunti
			80	Tutepani
			81	Tibetan Camp
			82	Ward 14, Nakhipot
			83	Puchowk Counter
15	349	mini container	84	Patan hospital

I-7 Results of Time and Motion of the Trial Operation at KMC

I. Time Taken for Loading and Unloading a New Vehicle (STVs)

Day: Thursday

Date: 2 March 2006

Venue: Teku Transfer Station, Kathmandu Metropolitan City Office.

Loading the new STVs

Load 1

Start Point: Main gate , Teku Transfer Station,

Vehicle No.Ba..1.Ka 5023

Vehicle Type: Truck

Ashok Leyland

Capacity: 15 m^3

Start Time: -10:12:20 a.m.
Travel Time at weighing platform: 10:12:55 a.m.
Vehicle weight without Waste (W1): 9,200 kg
Travel Time at reaching spirit level platform: 10:17:55 a.m.
Vehicle weight with waste (W2): 16,260 Kg.
Waste wt: W2-W1=7060 Kg

Trip.No	Vehicle type	Loading Time				Remarks
		Start Time	End Time	Time difference	C.T.	
1.	Mini compactor	10:23	10:24:40	1'40"	1'40"	Small adjustments of STVs location were made in between the loading
2.	Tipper	10:25:30	10:27:15	1'45"	3'25"	
3	Tipper	10:27:40	10:29:50	2"10"	5'35"	
4	Tipper	10:50:40	10:54:45	4'5"	9'40"	
	Total time taken to load (t1)				**9 min 40 sec**	

Note: C.T: Cumulative Time

Start time: Time at which the vehicle just started unloading waste into truck.

End time: Time at which the vehicle just got empty.

The tippers were driven to the platform for unloading. 1-2 tippers were placed in a queue. When one finished unloading and left the other arrived, got into position and unloaded. The time taken by a vehicle to reach platform from the ground and the time taken in position adjustment before unloading is neglected.

Load 2.

Vehicle Number: Ba 1. Ka 5026

Vehicle Type: Ashok Leyland Truck.

Capacity:15 m^3

Vehicle weight without Waste (W1): 9910 kg

Vehicle weight with waste (W2): 16,495 Kg.

Waste wt: W2-W1=6585 Kg.

Trip.No	Vehicle type	Loading time				Remarks
		Start Time	End Time	Time difference	C.T	
1.	Tipper	10:34:30	10:36	1'30"	1'30"	Some extra time was taken for adjusting truck position.
2.	Tipper	10:36:10	10:41:5	4'55"	6'25"	
3	Tipper	10:41:15	10:44:25	3'10"	9'35"	
4	Tipper	10:50:55	10:54:25	3'30"	13'5"	
	Total time taken to load(t2)				**13 min 5 sec**	

Start time: Time at which the vehicle just started unloading waste into truck.
End time: Time at which the vehicle just got empty.

The loading time for load 2 is higher than for Load 1. This could be due to the time taken in adjustments of tipper as well as truck during loading.

Average time for loading: (t1+t2)/2 = {(9min 40 sec) + (13min 5sec)}/2= 11min 22sec

Time taken for Unloading
Vehicle no: 5026
Weight unknown
Amount of waste carried: 4 trips tipper
Start time: 2:24:55 pm
End time: 2:30 pm
Total time taken for unloading: 5min 5 sec.

The average time taken for loading a new vehicle at spirit level platform is 11 min 22 sec. The total trips required by tipper having 3.5 m^3 capacities to fill the container of new vehicle are 4 trips. It 5 min 5 sec to unload the waste from the vehicle

II. Time Taken for Loading / Unloading a Compactor (Old Vehicle)

The compactor was loaded at ground level with help of a Back Hoe loader. The loader carried waste to its capacity and unloaded into compactor. Throughout the loading process the waste filled in the compactor were compacted time to time.

Vehicle Type: Compactor (Ashok Leyland)
Vehicle No.: Ba .1.Ka 3000
Capacity: 12 m3
Wt of Vehicle (Empty), W3=9,200 kg.
Wt. of Vehicle (Filled), W4=16,460 kg
Wt of waste: W4-W3=16,460-9,200=7,260 kg.
Start Time for Loading: 10:15 am.
End Time for Loading: 10:33:15am.
Time Taken for Loading: 18min 15sec

Three Compactor Drivers were asked to note down the unloading time at Sisdol.

Time taken by Compactor1 for Unloading waste at Sisdole: 5 min.

Time taken by Compactor2 for Unloading waste at Sisdole: 5: 13 min

Time taken by Compactor3 for Unloading waste at Sisdole: 4: 50 min

The average time taken for unloading waste at Sisdol Landfill site by a Compactor is about 5 mins.

I-8 Result of Time and Motion study of LSMC

I. Time Taken for Loading and Unloading a New Vehicle (STVs)

Day: Monday
Date: 13 March 2006
Start Point: LSMC Garage.
Vehicle No.5037
Vehicle Type: Truck
Ashok Leyland
Capacity: 15 m^3
Vehicle weight without Waste (W1): 9,910 kg
Vehicle weight without Waste (W2): 16,060 kg
Weight of waste (W1-W2): (16060-9910): 6150 kg

Arrival to Teku

S.no	Start Spot	End Spot	Distance (KM)	Start Time	End Time	Time diff	CT
1	Garage	Balkhu Bridge	6.5	11:35:05	11:51	15'55"	15'55"
2	Balkhu Bridge	Container	0.9	11:51	11:55:05	4'05"	20'
3	Loading(new veh: 5036) start	end		1:21:25	1:24:20	2'55"	22'55"
4	Container	Balkhu Bridge	0.9	1:28:20	1:33	4'40"	27'35"
5	Bakhu bridge	Kuleshwor	0.2	1:33	1:34:00	1'	28'35"
6	Kuleshwor	Kalimati chowk	1.5	1:34:00	1:38:05	3'55"	31'40"
7	Kalimati chowk	Municipality chowk(Teku)	0.5	1:38:05	1:40:20	2'15"	33'55"
8	Municipality chowk	Teku gate	0.5	1:40:20	1:42:50	2'30"	36'25"
9	Teku gate	weighing bridge		1:42:50	1:43:10	20 "	36'40"
10	weighing bridge	dumping site		1:46:00	1:47:40	1'40"	38'20"
11	start unloading(S)	end unloading(E)		1:49:25	1:52:38	4'13"	42'33"
	Total		**11 Km**				**42'33"**

Note:
S: Moment since the unloading started (vehicle arrangement time not included).
E: Time till container was just empty
Start time: time at which the engine was started
End Time: time at which the vehicle reached at each cross section.

The traffic condition was moderate. The total distance traveled is 11 Km. . Throughout the journey the roads were pitched except for the part, Balkhu Bridge to Bagmati Bank. Due to the problem in the hydraulic system of the vehicle no. 5037 was by replaced vehicle no. 5036.

Departure from Teku

S.no	Start Spot	End Spot	Distance (KM)	Start Time	End Time	Time diff.	CT
1	Teku Transfer station	Teku chowk	0.5	1:59:00	2:00	1”	1’
2	Teku chowk	Kalimati chowk	0.5	2:00	2:01:35	1’35”	2’35”
3	Kalimati	Kuleshwor	1.5	2:01:35	2:07:05	5’30”	8’5”
4	Kuleshwor	Balkhu Bridge	0.2	2:07:05	2:08:02	57”	9’2”
5	bridge	container	0.9	2:08:02	2:13:15	6’13”	15’15”
6	unloading empty container(S)	(E)		2:14:10	2:16:00	1’50”	17’5”
7	Loading empty container(start)	End -container fully loaded on truck		2:18:50	2:21:15	2’25”	19’30”
8	container	bridge	0.9	2:22:00	2:27:45	5’45”	25’15”
9	Bridge	Garage	6.5	2:27:45	2:44:30	16’45”	42’
	Total time(t2)		**11 Km**				**42’**

The total time taken for travel and loading/unloading is (t1+t2) 1hr 24min 33sec

Supporting Report J

Operation Record of Sisdol Landfill

Supporting Report J: Operation of Sisdol LF

J-1 Operation Monitoring Visit Form (Sample)

Operation Monitoring Visit Report							
1. VISIT CONDITIONS							
1.1 Date	2006/5/3	1.2 Time	9:30	1.3 Weather	1		
	21/11/062		2.30 PM				
2. LANDFILL OPERATION							
2.1 Waste Face		a) Zone	3	b) Height	2.5		
		c) Unloading		d) Placing			
		- Near Face	1	- Push down/U	1		
		d) Trips	7	e) Amount	41.5	f) Measured	2
2.2 Soil cover		a) Active cell	1	b) Old cells	1	c) Source	1
				(problem Zone)			
2.3 Leachate Pond		a) Water level	17	b) Outlet pipe	21.60		
2.4 Manhole		a) Valve leak	2	b) Water level	1	c) Odor	2
2.5 Outfall		a) Discharge	2	b) Stagnated leachate at outfall			2
2.6 Slopes condition		a) Sliding	2	b) Collapse	2		
		- Zone		- Zone			
2.7 Perimeter drain		a) Water flow	1	b) Free flow	1	c) Disch. at ch	0.00
2.8 Internal Road		a) Pavement	1	b) Side drains	1		
2.9 LP Access road		a) Condition	1				
2.10 Sprinkler system		a) In use?	2	b) Where		c) Ponding	2
3. EQUIPMENT CONDITIONS							
3.1 Weighbridge		a) In operation	2	b) If yes, hours			
3.2 Aerator		a) In operation	1	b) If yes, hours	3		
3.3 Re-circulation pump		a) In operation	1	b) If yes, hours	3		
3.4 Generator I (PP)		a) In operation	1	b) If yes, hours	6		
3.5 Generator II		a) In operation	2	b) If yes, hours			
3.6 Bulldozer		a) In operation	1	b) If yes, hours	4		
3.7 Excavator		a) In operation	1	b) If yes, hours	1		
3.8 Water tanker		a) In operation	2	b) If yes, hours			
4. MANPOWER							
		a) SWM Chief		b) Site Manager		c) Supervisor	1
		d) Dozer driver	1	e) Excavator D	1	f) LC Rep	1
		g) Workers	1	h) Guardmen	1		
		- How many?	6		2		
5. ENVIRONMENTAL CONCERNS							
5.1 Odor		a) Waste face	2	b) LP	2	c) Admin area	2
5.2 Flies, mosquitoes		a) Waste face	2	b) LP	2	c) Admin area	2
5.3 Dogs		a) Waste face	1	b) LP	2	c) Admin area	2
5.4 Birds		a) Waste face	1	b) LP	2	c) Admin area	2
5.5 Scavengers		a) Waste face	2	b) LP	2	c) Admin area	2
5.6 Waste scattering		a) Waste face	2	b) LP	2	c) Admin area	2
5.7 Seepage into River		a) Detected?	2	b) Where			
5.8 Public complaints		a) Any?	2	c) Type 1		d) Type 2	
				e) Type 3		f) Type 4	
6. OTHERS							
6.1 Site Records		a) Waste arriva	1	b) Operations	1	c) Visitors	1
6.2 Water supply		a) Available	1	b) Sufficient	1		
6.3 Electricity Supply		a) Available	2	b) Outage	2		
6.4 Telephone		a) Available	2	b) Outage	2		
6.5 Hand phone		a) Can use?	1				
6.6 BH Conditions		a) BH1 capped	1	b) BH1 fenced	1		
		a) BH2 capped	1	b) BH2 fenced	1		
6.7 Visitors		a) Number	3	b) Names/titles	Mr. Riad, CKV Study team.		
					Mr. Deepak Shrestha, ENPHO		
					Mr. Vishnu Koirala, ENPHO		
7. COMMENTS							
(Technical advise given to Operators, necessary improvements, equipment breakdowns or repairs, access roac waste types, etc.)							
7.1	Samples has been taken by ENPHO from upstream of kolpukhola & tholakhola, down stream of Kolpukhola, BH 1, BH 2, before aeration leachate from east pond & west pond and after 3 hour operation of aerator east & west pond.						
7.2	After two week observation of leachate re-circulation on leachate pond to leachate re-circulation pond (New pond), rate of leachate discharge is increase by 8 cu.m per day (23 cu.m. /day) than before but re-circulation of leachate is more than 25 cu.m. I						
7.3	Electric (11m) pole has been erected on access road near leached pond.						

J-2 Records of Waste Arrivals

(1) December 2005

No	Date	Day	Waste trips			Waste Amounts			Soil cover	Soil/Waste
			KMC	LSMC	Total	KMC	LSMC	Total	(tons)	ratio
1	2005/12/11	Sun	4	1	5	30.00	2.00	32.00	6	19%
2	2005/12/12	Mon	2	1	3	15.00	2.00	17.00	0	0%
3	2005/12/13	Tue	5	1	6	37.50	2.00	39.50	0	0%
4	2005/12/14	Wed	5	1	6	37.50	2.00	39.50	30	76%
5	2005/12/15	Thu	0	1	1	0.00	2.00	2.00	0	0%
6	2005/12/16	Fri	0	0	0	0.00	0.00	0.00	0	0%
7	2005/12/17	Sat	4	1	5	30.00	2.00	32.00	0	0%
8	2005/12/18	Sun	4	2	6	30.00	4.00	34.00	6	18%
9	2005/12/19	Mon	3	1	4	6.00	2.00	8.00	0	0%
10	2005/12/20	Tue	6	1	7	12.00	2.00	14.00	15	107%
11	2005/12/21	Wed	0	0	0	0.00	0.00	0.00	0	0%
12	2005/12/22	Thu	7	0	7	47.00	0.00	47.00	0	0%
13	2005/12/23	Fri	4	0	4	30.00	0.00	30.00	0	0%
14	2005/12/24	Sat	0	0	0	0.00	0.00	0.00	0	0%
15	2005/12/25	Sun	0	0	0	0.00	0.00	0.00	0	0%
16	2005/12/26	Mon	10	1	11	69.50	2.00	71.50	2	3%
17	2005/12/27	Tue	9	1	10	62.00	2.00	64.00	2	3%
18	2005/12/28	Wed	7	1	8	47.00	2.00	49.00	0	0%
19	2005/12/29	Thu	7	1	8	47.00	2.00	49.00	0	0%
20	2005/12/30	Fri	13	1	14	92.00	2.00	94.00	60	64%
21	2005/12/31	Sat	9	1	10	62.00	2.00	64.00	40	63%

(2) January 2006

No	Date	Day	Waste trips			Waste Amounts			Soil cover	Soil/Waste
			KMC	LSMC	Total	KMC	LSMC	Total	(tons)	ratio
22	2006/1/1	Sun	13	1	14	92.00	2.00	94.00	60	64%
23	2006/1/2	Mon	7	1	8	47.00	2.00	49.00	0	0%
24	2006/1/3	Tue	10	1	11	69.50	2.00	71.50	0	0%
25	2006/1/4	Wed	4	1	5	24.50	2.00	26.50	30	113%
26	2006/1/5	Thu	5	1	6	32.00	2.00	34.00	0	0%
27	2006/1/6	Fri	11	1	12	71.50	2.00	73.50	0	0%
28	2006/1/7	Sat	8	1	9	54.50	2.00	56.50	0	0%
29	2006/1/8	Sun	8	1	9	60.00	2.00	62.00	0	0%
30	2006/1/9	Mon	8	1	9	54.50	2.00	56.50	4	7%
31	2006/1/10	Tue	9	1	10	62.00	2.00	64.00	0	0%
32	2006/1/11	Wed	8	1	9	60.00	2.00	62.00	0	0%
33	2006/1/12	Thu	5	1	6	47.00	2.00	49.00	50	102%
34	2006/1/13	Fri	6	1	7	39.50	2.00	41.50	80	193%
35	2006/1/14	Sat	4	1	5	30.00	2.00	32.00	0	0%
36	2006/1/15	Sun	4	1	5	24.50	2.00	26.50	0	0%
37	2006/1/16	Mon	5	1	6	32.00	2.00	34.00	4	12%
38	2006/1/17	Tue	7	1	8	47.00	2.00	49.00	0	0%
39	2006/1/18	Wed	7	1	8	47.00	2.00	49.00	100	204%
40	2006/1/19	Thu	10	1	11	75.00	2.00	77.00	0	0%
41	2006/1/20	Fri	0	0	0	0.00	0.00	0.00	0	0%
42	2006/1/21	Sat	5	1	6	32.00	2.00	34.00	40	118%
43	2006/1/22	Sun	6	1	7	39.50	2.00	41.50	0	0%
44	2006/1/23	Mon	4	1	5	24.50	2.00	26.50	100	377%
45	2006/1/24	Tue	11	1	12	77.00	2.00	79.00	0	0%
46	2006/1/25	Wed	11	1	12	77.00	2.00	79.00	0	0%
47	2006/1/26	Thu	0	0	0	0.00	0.00	0.00	0	0%
48	2006/1/27	Fri	10	1	11	75.00	2.00	77.00	60	78%
49	2006/1/28	Sat	4	1	5	30.00	2.00	32.00	0	0%
50	2006/1/29	Sun	5	1	6	32.00	2.00	34.00	0	0%
51	2006/1/30	Mon	11	1	12	77.00	2.00	79.00	100	127%
52	2006/1/31	Tue	0	0	0	0.00	0.00	0.00	0	0%

(3) February 2006

No	Date	Day	Waste trips			Waste Amounts			Soil cover	Soil/Waste
			KMC	LSMC	Total	KMC	LSMC	Total	(tons)	ratio
53	2006/2/1	Wed	10	1	11	77.00	2.00	79.00	40	51%
54	2006/2/2	Thu	5	1	6	32.00	2.00	34.00	48	141%
55	2006/2/3	Fri	5	1	6	32.00	2.00	34.00	52	153%
56	2006/2/4	Sat	5	1	6	32.00	2.00	34.00	100	294%
57	2006/2/5	Sun	0	0	0	0.00	0.00	0.00	0	0%
58	2006/2/6	Mon	0	0	0	0.00	0.00	0.00	0	0%
59	2006/2/7	Tue	0	0	0	0.00	0.00	0.00	0	0%
60	2006/2/8	Wed	0	0	0	0.00	0.00	0.00	0	0%
61	2006/2/9	Thu	0	0	0	0.00	0.00	0.00	0	0%
62	2006/2/10	Fri	0	1	1	0.00	2.00	2.00	0	0%
63	2006/2/11	Sat	7	1	8	47.00	2.00	49.00	36	73%
64	2006/2/12	Sun	10	1	11	77.00	2.00	79.00	0	0%
65	2006/2/13	Mon	0	0	0	0.00	0.00	0.00	0	0%
66	2006/2/14	Tue	0	0	0	0.00	0.00	0.00	0	0%
67	2006/2/15	Wed	12	1	13	84.50	2.00	86.50	60	69%
68	2006/2/16	Thu	14	1	15	99.50	2.00	101.50	100	99%
69	2006/2/17	Fri	12	1	13	84.50	2.00	86.50	80	92%
70	2006/2/18	Sat	7	1	8	47.00	2.00	49.00	0	0%
71	2006/2/19	Sun	8	1	9	54.50	2.00	56.50	0	0%
72	2006/2/20	Mon	13	1	14	92.00	2.00	94.00	0	0%
73	2006/2/21	Tue	15	1	16	107.00	2.00	109.00	100	92%
74	2006/2/22	Wed	11	1	12	77.00	2.00	79.00	100	127%
75	2006/2/23	Thu	13	1	14	92.00	2.00	94.00	0	0%
76	2006/2/24	Fri	8	1	9	54.50	2.00	56.50	60	106%
77	2006/2/25	Sat	0	0	0	0.00	0.00	0.00	0	0%
78	2006/2/26	Sun	0	0	0	0.00	0.00	0.00	0	0%
79	2006/2/27	Mon	0	0	0	0.00	0.00	0.00	0	0%
80	2006/2/28	Tue	11	0	11	55.00	0.00	55.00	0	0%

(4) March 2006

No	Date	Day	Waste trips			Waste Amounts			Soil cover	Soil/Waste
			KMC	LSMC	Total	KMC	LSMC	Total	(tons)	ratio
81	2006/3/1	Wed	7	1	8	47.00	2.00	49.00	60	122%
82	2006/3/2	Thu	13	1	14	92.00	2.00	94.00	60	64%
83	2006/3/3	Fri	11	1	12	77.00	2.00	79.00	40	51%
84	2006/3/4	Sat	5	1	6	32.00	2.00	34.00	0	0%
85	2006/3/5	Sun	7	1	8	47.00	2.00	49.00	50	102%
86	2006/3/6	Mon	6	1	7	45.00	2.00	47.00	40	85%
87	2006/3/7	Tue	6	1	7	45.00	2.00	47.00	0	0%
88	2006/3/8	Wed	6	1	7	45.00	2.00	47.00	0	0%
89	2006/3/9	Thu	10	1	11	69.50	2.00	71.50	100	140%
90	2006/3/10	Fri	14	1	15	99.50	2.00	101.50	88	87%
91	2006/3/11	Sat	12	1	13	84.50	2.00	86.50	0	0%
92	2006/3/12	Sun	14	1	15	107.00	2.00	109.00	100	91.70%
93	2006/3/13	Mon	11	1	12	77.00	2.00	79.00	60	76%
94	2006/3/14	Tue	0	0	0	0.00	0.00	0.00	0	0%
95	2006/3/15	Wed	0	0	0	0.00	0.00	0.00	0	0%
96	2006/3/16	Thu	0	0	0	0.00	0.00	0.00	0	0%
97	2006/3/17	Fri	0	0	0	0.00	0.00	0.00	0	0%
98	2006/3/18	Sat	0	0	0	0.00	0.00	0.00	0	0%
99	2006/3/19	Sun	0	0	0	0.00	0.00	0.00	0	0%
100	2006/3/20	Mon	4	1	5	30.00	2.00	32.00	0	0%
101	2006/3/21	Tue	7	1	8	47.00	2.00	49.00	60	122%
102	2006/3/22	Wed	5	1	6	37.50	2.00	39.50	0	0%
103	2006/3/23	Thu	6	1	7	39.50	2.00	41.50	0	0%
104	2006/3/24	Fri	10	1	11	69.50	2.00	71.50	60	84%
105	2006/3/25	Sat	5	1	6	32.00	2.00	34.00	0	0%
106	2006/3/26	Sun	5	1	6	32.00	2.00	34.00	100	294%
107	2006/3/27	Mon	5	1	6	32.00	2.00	34.00	0	0%
108	2006/3/28	Tue	5	1	6	37.50	2.00	39.50	0	0%
109	2006/3/29	Wed	5	1	6	32.00	2.00	34.00	58	171%
110	2006/3/30	Thu	9	1	10	62.00	2.00	64.00	0	0%
111	2006/3/31	Fri	8	1	9	54.50	2.00	56.50	60	106%

(5) April 2006

No	Date	Day	Waste trips			Waste Amounts			Soil cover	Soil/Waste
			KMC	LSMC	Total	KMC	LSMC	Total	(tons)	ratio
112	2006/4/1	Sat	5	1	6	32.00	2.00	34.00	0	0%
113	2006/4/2	Sun	3	1	6	17.00	2.00	19.00	0	0%
114	2006/4/3	Mon	0	1	1	0.00	2.00	2.00	30	1500%
115	2006/4/4	Tue	0	1	1	0.00	2.00	2.00	0	0%
116	2006/4/5	Wed	8	3	11	32.50	6.00	38.50	22	57%
117	2006/4/6	Thu	0	0	0	0.00	0.00	0.00	0	0%
118	2006/4/7	Fri	0	0	0	0.00	0.00	0.00	0	0%
119	2006/4/8	Sat	0	0	0	0.00	0.00	0.00	0	0%
120	2006/4/9	Sun	0	0	0	0.00	0.00	0.00	0	0%
121	2006/4/10	Mon	0	0	0	0.00	0.00	0.00	0	0%
122	2006/4/11	Tue	0	0	0	0.00	0.00	0.00	0	0%
123	2006/4/12	Wed	0	0	0	0.00	0.00	0.00	0	0%
124	2006/4/13	Thu	0	0	0	0.00	0.00	0.00	0	0%
125	2006/4/14	Fri	0	0	0	0.00	0.00	0.00	0	0%
126	2006/4/15	Sat	0	0	0	0.00	0.00	0.00	0	0%
127	2006/4/16	Sun	0	0	0	0.00	0.00	0.00	0	0%
128	2006/4/17	Mon	0	0	0	0.00	0.00	0.00	0	0%
129	2006/4/18	Tue	0	0	0	0.00	0.00	0.00	0	0%
130	2006/4/19	Wed	0	0	0	0.00	0.00	0.00	0	0%
131	2006/4/20	Thu	0	0	0	0.00	0.00	0.00	0	0%
132	2006/4/21	Fri	0	0	0	0.00	0.00	0.00	0	0%
133	2006/4/22	Sat	0	0	0	0.00	0.00	0.00	0	0%
134	2006/4/23	Sun	0	0	0	0.00	0.00	0.00	0	0%
135	2006/4/24	Mon	0	0	0	0.00	0.00	0.00	0	0%
136	2006/4/25	Tue	0	0	0	0.00	0.00	0.00	0	0%
137	2006/4/26	Wed	0	0	0	0.00	0.00	0.00	0	0%
138	2006/4/27	Thu	0	0	0	0.00	0.00	0.00	0	0%
139	2006/4/28	Fri	0	0	0	0.00	0.00	0.00	0	0%
140	2006/4/29	Sat	0	0	0	0.00	0.00	0.00	0	0%
141	2006/4/30	Sun	6	1	7	45.00	2.00	47.00	0	0%

(6) May 2006

No	Date	Day	Waste trips			Waste Amounts			Soil cover	Soil/Waste
			KMC	LSMC	Total	KMC	LSMC	Total	(tons)	ratio
142	2006/5/1	Mon	7	1	8	47.00	2.00	49.00	60	
143	2006/5/2	Tue	5	1	6	37.50	2.00	39.50	30	
144	2006/5/3	Wed	13	1	14	92.00	2.00	94.00	0	
145	2006/5/4	Thu	19	1	20	104.00	2.00	106.00	80	
146	2006/5/5	Fri	21	1	22	102.50	2.00	104.50	60	
147	2006/5/6	Sat	40	1	41	229.50	2.00	231.50	60	
148	2006/5/7	Sun	34	1	35	216.50	2.00	218.50	60	
149	2006/5/8	Mon	44	1	45	260.00	2.00	262.00	80	
150	2006/5/9	Tue	37	2	39	266.50	9.50	276.00	100	
151	2006/5/10	Wed	44	2	46	324.50	9.50	334.00	80	
152	2006/5/11	Thu	40	2	42	294.50	9.50	304.00	40	
153	2006/5/12	Fri	21	2	23	132.00	11.00	143.00	110	
154	2006/5/13	Sat	34	2	36	222.00	9.50	231.50	100	
155	2006/5/14	Sun	72	2	74	495.50	13.00	508.50	140	
156	2006/5/15	Mon	77	2	79	597.50	13.50	611.00	110	
157	2006/5/16	Tue	80	4	84	532.00	32.00	564.00	40	
158	2006/5/17	Wed	87	3	90	629.50	23.50	653.00	150	
159	2006/5/18	Thu	28	1	29	116.50	3.00	119.50	180	
160	2006/5/19	Fri	72	4	76	508.50	33.50	542.00	0	
161	2006/5/20	Sat	84	4	88	649.00	33.50	682.50	150	
162	2006/5/21	Sun	65	4	69	374.50	24.50	399.00	150	
163	2006/5/22	Mon	47	4	51	319.50	24.50	344.00	100	
164	2006/5/23	Tue	25	3	28	169.50	17.00	186.50	120	
165	2006/5/24	Wed	35	3	38	251.50	17.00	268.50	80	
166	2006/5/25	Thu	37	0	37	266.50	0.00	266.50	60	
167	2006/5/26	Fri	45	4	49	319.00	24.50	343.50	100	
168	2006/5/27	Sat	35	5	40	246.00	32.00	278.00	90	
169	2006/5/28	Sun	31	2	33	223.50	15.00	238.50	100	
170	2006/5/29	Mon	21	4	25	152.00	19.00	171.00	60	
171	2006/5/30	Tue	54	6	60	383.00	34.00	417.00	100	
172	2006/5/31	Wed	52	5	57	368.00	26.50	394.50	108	

(7) June 2006

No	Date	Day	Waste trips			Waste Amounts			Soil cover	Soil/Waste
			KMC	LSMC	Total	KMC	LSMC	Total	(tons)	ratio
173	2006/6/1	Thu	45	1	46	333.00	7.50	340.50	100	
174	2006/6/2	Fri	5	4	9	32.00	19.00	51.00	0	
175	2006/6/3	Sat	38	2	40	268.50	4.00	272.50	120	
176	2006/6/4	Sun	40	4	44	283.50	19.00	302.50	60	
177	2006/6/5	Mon	34	4	38	244.00	24.50	268.50	120	
178	2006/6/6	Tue	58	5	63	424.00	32.00	456.00	120	
179	2006/6/7	Wed	59	5	64	431.50	26.50	458.00	120	
180	2006/6/8	Thu	45	5	50	326.50	32.00	358.50	172	
181	2006/6/9	Fri	45	5	50	321.00	10.00	331.00	120	
182	2006/6/10	Sat	41	3	44	296.50	17.00	313.50	90	
183	2006/6/11	Sun	40	4	44	300.00	24.50	324.50	120	
184	2006/6/12	Mon	53	4	57	381.00	24.50	405.50	148	
185	2006/6/13	Tue	40	5	45	294.50	32.00	326.50	160	
186	2006/6/14	Wed	41	4	45	296.50	24.50	321.00	120	
187	2006/6/15	Thu	49	10	59	369.50	40.00	409.50	80	
188	2006/6/16	Fri	49	12	61	351.00	46.00	397.00	60	
189	2006/6/17	Sat	31	9	40	227.00	40.00	267.00	90	
190	2006/6/18	Sun	39	10	49	279.50	36.50	316.00	120	
191	2006/6/19	Mon	40	5	45	283.50	21.00	304.50	90	
192	2006/6/20	Tue	35	6	41	257.00	34.00	291.00	100	
193	2006/6/21	Wed	23	6	29	167.00	23.00	190.00	90	
194	2006/6/22	Thu	61	10	71	441.00	42.00	483.00	60	
195	2006/6/23	Fri	57	9	66	411.00	34.50	445.50	90	
196	2006/6/24	Sat	40	7	47	289.00	25.00	314.00	90	
197	2006/6/25	Sun	38	4	42	279.50	19.00	298.50	100	
198	2006/6/26	Mon	43	7	50	306.00	25.00	331.00	120	
199	2006/6/27	Tue	57	8	65	416.50	32.50	449.00	120	
200	2006/6/28	Wed	42	11	53	314.00	34.00	348.00	120	
201	2006/6/29	Thu	48	9	57	343.50	34.50	378.00	88	
202	2006/6/30	Fri	34	10	44	244.00	36.50	280.50	82	

(8) July 2006

No	Date	Day	Waste trips			Waste Amounts		
			KMC	LSMC	Total	KMC	LSMC	Total
203	2006/7/1	Sat	27	8	35	197.00	38.00	235.00
204	2006/7/2	Sun	43	8	51	311.50	27.00	338.50
205	2006/7/3	Mon	44	11	55	319.00	44.00	363.00
206	2006/7/4	Tue	43	8	51	317.00	32.50	349.50
207	2006/7/5	Wed	35	10	45	251.50	42.00	293.50
208	2006/7/6	Thu	54	8	62	379.00	40.00	419.00
209	2006/7/7	Fri	60	11	71	433.50	44.00	477.50
210	2006/7/8	Sat	40	12	52	283.50	46.00	329.50
211	2006/7/9	Sun	45	7	52	321.00	25.00	346.00
212	2006/7/10	Mon	56	10	66	409.00	31.00	440.00
213	2006/7/11	Tue	37	12	49	272.00	46.00	318.00
214	2006/7/12	Wed	62	12	74	400.50	46.00	446.50
215	2006/7/13	Thu			0			0.00
216	2006/7/14	Fri			0			0.00
217	2006/7/15	Sat			0			0.00
218	2006/7/16	Sun			0			0.00
219	2006/7/17	Mon			0			0.00
220	2006/7/18	Tue			0			0.00
221	2006/7/19	Wed	46	0	46	328.50	0.00	328.50
222	2006/7/20	Thu	60	3	63	416.50	22.50	439.00
223	2006/7/21	Fri	54	10	64	405.00	36.50	441.50
224	2006/7/22	Sat	54	10	64	361.00	31.00	392.00
225	2006/7/23	Sun	22	5	27	110.00	21.00	131.00
226	2006/7/24	Mon	86	10	96	507.50	31.00	538.50
227	2006/7/25	Tue	46	8	54	240.50	27.00	267.50
228	2006/7/26	Wed			0			0.00
229	2006/7/27	Thu			0			0.00
230	2006/7/28	Fri			0			0.00
231	2006/7/29	Sat			0			0.00
232	2006/7/30	Sun			0			0.00
233	2006/7/31	Mon			0			0.00

(9) October 2006

No	Date	Day	Waste trips			Waste Amounts		
			KMC	LSMC	Total	KMC	LSMC	Total
295	2006/10/1	Sun			0			0.00
296	2006/10/2	Mon			0			0.00
297	2006/10/3	Tue			0			0.00
298	2006/10/4	Wed			0			0.00
299	2006/10/5	Thu			0			0.00
300	2006/10/6	Fri			0			0.00
301	2006/10/7	Sat			0			0.00
302	2006/10/8	Sun			0			0.00
303	2006/10/9	Mon			0			0.00
304	2006/10/10	Tue			0			0.00
305	2006/10/11	Wed			0			0.00
306	2006/10/12	Thu			0			0.00
307	2006/10/13	Fri			0			0.00
308	2006/10/14	Sat			0			0.00
309	2006/10/15	Sun			0			0.00
310	2006/10/16	Mon	25	4	29	176.50	30.00	206.50
311	2006/10/17	Tue			0			0.00
312	2006/10/18	Wed	41	9	50	278.50	40.00	318.50
313	2006/10/19	Thu	58	2	60	347.50	15.00	362.50
314	2006/10/20	Fri	81	4	85	515.50	30.00	545.50
315	2006/10/21	Sat	47	0	47	250.50	0.00	250.50
316	2006/10/22	Sun	65	4	69	421.00	30.00	451.00
317	2006/10/23	Mon	56	4	60	359.50	24.50	384.00
318	2006/10/24	Tue			0			0.00
319	2006/10/25	Wed	48	3	51	335.00	17.00	352.00
320	2006/10/26	Thu	66	3	69	404.50	17.00	421.50
321	2006/10/27	Fri	79	3	82	497.00	17.00	514.00
322	2006/10/28	Sat	64	5	69	391.50	32.00	423.50
323	2006/10/29	Sun	74	0	74	460.50	0.00	460.50
324	2006/10/30	Mon	73	6	79	484.50	45.00	529.50
325	2006/10/31	Tue	74	3	77	492.00	17.00	509.00

(10) November 2006

No	Date	Day	Waste trips			Waste Amounts		
			KMC	LSMC	Total	KMC	LSMC	Total
326	2006/11/1	Wed	55	4	59	377.50	30.00	407.50
327	2006/11/2	Thu	55	2	57	372.00	15.00	387.00
328	2006/11/3	Fri	48	4	52	333.50	24.50	358.00
329	2006/11/4	Sat	46	5	51	285.00	32.00	317.00
330	2006/11/5	Sun	39	1	40	243.00	2.00	245.00
331	2006/11/6	Mon	54	5	59	359.50	32.00	391.50
332	2006/11/7	Tue	57	5	62	364.00	32.00	396.00
333	2006/11/8	Wed	62	4	66	396.50	30.00	426.50
334	2006/11/9	Thu	42	0	42	315.00	0.00	315.00
335	2006/11/10	Fri	42	3	45	238.50	17.00	255.50
336	2006/11/11	Sat	33	4	37	226.50	24.50	251.00
337	2006/11/12	Sun	52	5	57	312.50	32.00	344.50
338	2006/11/13	Mon	53	5	58	359.00	32.00	391.00
339	2006/11/14	Tue	59	4	63	386.50	30.00	416.50
340	2006/11/15	Wed	54	4	58	348.50	24.50	373.00
341	2006/11/16	Thu	50	4	54	302.00	30.00	332.00
342	2006/11/17	Fri	48	4	52	306.50	24.50	331.00
343	2006/11/18	Sat	22	3	25	146.50	17.00	163.50
344	2006/11/19	Sun	31	1	32	186.50	7.50	194.00
345	2006/11/20	Mon	43	5	48	266.00	37.50	303.50
346	2006/11/21	Tue			0			0.00
347	2006/11/22	Wed			0			0.00
348	2006/11/23	Thu			0			0.00
349	2006/11/24	Fri	37	0	37	277.50	0.00	277.50
350	2006/11/25	Sat	32	0	32	194.00	0.00	194.00
351	2006/11/26	Sun	43	5	48	266.00	37.50	303.50
352	2006/11/27	Mon	55	4	59	349.00	30.00	379.00
353	2006/11/28	Tue	28	3	31	178.00	17.00	195.00
354	2006/11/29	Wed	63	5	68	389.50	32.00	421.50
355	2006/11/30	Thu	45	4	49	282.50	24.50	307.00

(11) December 2006

No	Date	Day	Waste trips			Waste Amounts		
			KMC	LSMC	Total	KMC	LSMC	Total
356	2006/12/1	Fri	37	5	42	235.00	32.00	267.00
357	2006/12/2	Sat	31	3	34	184.50	17.00	201.50
358	2006/12/3	Sun	43	5	48	274.50	32.00	306.50
359	2006/12/4	Mon	48	3	51	317.50	22.50	340.00
360	2006/12/5	Tue	53	5	58	339.50	32.00	371.50
361	2006/12/6	Wed	50	5	55	325.50	32.00	357.50
362	2006/12/7	Thu	49	5	54	268.50	32.00	300.50
363	2006/12/8	Fri	6	0	6	24.00	0.00	24.00
364	2006/12/9	Sat	33	2	35	206.50	15.00	221.50
365	2006/12/10	Sun	57	4	61	378.00	30.00	408.00
366	2006/12/11	Mon	50	5	55	332.50	32.00	364.50
367	2006/12/12	Tue	41	5	46	261.50	32.00	293.50
368	2006/12/13	Wed	49	5	54	309.00	32.00	341.00
369	2006/12/14	Thu	48	2	50	314.00	15.00	329.00
370	2006/12/15	Fri	35	4	39	220.50	30.00	250.50
371	2006/12/16	Sat	24	3	27	153.50	17.00	170.50
372	2006/12/17	Sun	55	4	59	338.00	24.50	362.50
373	2006/12/18	Mon	46	3	49	308.00	17.00	325.00
374	2006/12/19	Tue	37	3	40	224.00	17.00	241.00
375	2006/12/20	Wed	52	5	57	330.00	32.00	362.00
376	2006/12/21	Thu	50	5	55	313.00	32.00	345.00
377	2006/12/22	Fri	47	4	51	294.00	24.50	318.50
378	2006/12/23	Sat	31	3	34	179.00	17.00	196.00
379	2006/12/24	Sun	51	5	56	327.50	32.00	359.50
380	2006/12/25	Mon	64	5	69	416.00	32.00	448.00
381	2006/12/26	Tue	51	5	56	331.00	32.00	363.00
382	2006/12/27	Wed	32	2	34	211.50	9.50	221.00
383	2006/12/28	Thu	57	5	62	360.00	32.00	392.00
384	2006/12/29	Fri	6	0	6	39.50	0.00	39.50
385	2006/12/30	Sat	34	4	38	238.50	24.50	263.00
386	2006/12/31	Sun			0			386.50

J-3 Records of Equipment Operation

(1) December 2005 and January 2006

Dec	Operation Hours							Jan	Operation Hours						
	Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compac	Loader/ Excavator		Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compac	Loader/ Excavator
								1	0	0	0	0	0	5	3
								2	0	0	0	0	0	2	1
								3	0	0	0	0	0	3	1
								4	0	0	0	0	0	3	2
								5	0	0	0	0	0	4	3
								6	0	1	0	1	0	4	0
								7	0	0	4	4	0	0	1
								8	0	2	4	6	0	3	2
								9	0	0	0	0	0	2	1
								10	0	1	3	4	0	3	0
11	0	2	2	4	0	4	0	11	0	2	4	6	0	4	0
12	0	2	2	4	0	2	0	12	0	6	0	6	0	5	2
13	0	0	4	4	0	3	0	13	0	2	4	6	0	4	2
14	0	1	2	3	0	6	0	14	0	0	0	0	0	3	0
15	0	3	0	3	0	0	0	15	0	0	0	0	0	3	0
16	0	0	0	0	0	0	0	16	0	4	2	6	0	2.5	1
17	0	3	2	5	0	3	0	17	0	0	0	0	0	1.5	0
18	0	4	1	5	0	1.5	0	18	0	0	6	6	0	3.5	2
19	0	1	1	2	0	1	0	19	0	0	6	6	0	5	1
20	0	1	1	2	0	2	1	20	0	0	0	0	0	0	0
21	0	1	0	1	0	0	0	21	0	0	6	6	0	3	1
22	0	2	0	2	0	3	0	22	0	0	7	7	0	3	1
23	0	0	0	0	0	1	0	23	0	0	6	6	0	4	2
24	0	2	2	4	0	0	0	24	0	0.75	5.25	6	0	5	0
25	0	1	3	4	0	0	0	25	0	0	0	0	0	6	3
26	0	4	2	6	0	5	0	26	0	0	6	6	0	0	0
27	0	0.5	5	6	0	3	0	27	0	0	6	6	0	4	3
28	0	4	0	4	0	2	0	28	0	0	0	0	0	2	0
29	0	3	1	4	0	0	0	29	0	0	0	0	0	0	0
30	0	0	2	2	0	5	1	30	0	0	4	4	0	3	3
31	0	0	0	0	0	5	3	31	0	0	0	0	0	0	0

(2) February 2006 and March 2006

Feb	Operation Hours							Mar	Operation Hours						
	Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compac	Loader/ Excavator		Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compac	Loader/ Excavator
1	0	0	6	6	0	4	1	1	0	2	4	6	0	5	4
2	0	0	0	0	0	3	1	2	0	3	3	6	0	6	4
3	0	0	5	5	0	3	1	3	0	1	2	3	0	5	2
4	0	0	0	0	0	4	3	4	0	0	6	6	0	3	1
5	0	0	0	0	0	0	0	5	0	6	0	6	0	4	1
6	0	0	0	0	0	0	0	6	0	4	2	6	0	4	2
7	0	0	0	0	0	0	0	7	0	0	0	0	0	3	1
8	0	0	0	0	0	0	0	8	0	0	0	0	0	4	2
9	0	0	0	0	0	0	0	9	0	4	2	6	0	6	4
10	0	0	0	0	0	0	0	10	0	4	2	6	0	6	2
11	0	0	0	0	0	0	1	11	0	4	2	6	0	4.5	1
12	0	0	0	0	0	6	1	12	0	4	2	6	0	6	3
13	0	0	0	0	0	0	0	13	0	2	4	6	0	5.5	2
14	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0
15	0	0	0	0	0	5	3	15	0	0	0	0	0	0	0
16	0	0	3	3	0	6	3	16	0	0	0	0	0	0	0
17	0	0	7	7	0	6	3	17	0	0	0	0	0	0	0
18	0	0	0	0	0	2.5	1	18	0	0	0	0	0	0	0
19	0	0	0	0	0	4	1	19	0	0	0	0	0	0	0
20	0	0	0	0	0	6.5	3	20	0	0	0	0	0	3	0
21	0	1	0	1	0	7	5	21	0	6	0	6	0	4	0
22	0	3	5	8	0	5.5	3	22	0	5	1	6	0	2	0
23	0	3	3	6	0	5.5	2	23	0	4	0	4	0	2	1
24	0	3	3	6	0	5	3	24	0	0	0	0	0	5	1
25	0	0	0	0	0	1	0	25	0	0	0	0	0	3	0
26	0	0	0	0	0	1	0	26	0	0	0	0	0	1.5	0
27	0	0	0	0	0	1	0	27	0	0	0	0	0	3	1
28	0	0	6	6	0	5	0	28	0	0	0	0	0	3	0
								29	0	0	0	0	0	3	1
								30	0	0	0	0	0	5	1
								31	0	0	6	6	0	5.5	3

(3) April, May and June 2006

Apr	Operation Hours							May	Operation Hours							June	Operation Hours						
	Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compa	Loader/ Excavator		Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compa	Loader/ Excavator		Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compa	Loader/ Excavator
1	0	0	6	6	0	3	1	1	0	1	5	6	0	3	2	1	0	3	0	3	0	10	7
2	0	2	3	5	0	2	1	2	0	2	5	6	0	3	2	2	0	3	0	3	0	3.5	2
3	0	1	5	6	0	1	2	3	0	0	0	0	0	7	0	3	0	3	0	3	0	10	4
4	0	6	0	6	0	4	0	4	0	1	2	3	0	6	4	4	0	3	0	3	0	7	5
5	0	0	6	6	0	2.5	1	5	0	0	0	0	0	6	2	5	0	3	0	3	0	9	4
6	0	1	5	6	0	0	0	6	0	0	0	0	0	7	1	6	0	0	0	0	0	12	4
7	0	1	5	6	0	0	0	7	0	0	3	3	0	7	3	7	0	3	0	3	0	12	3
8	0	0	0	0	0	0	0	8	0	0	0	0	0	9	4	8	0	6	0	6	0	6.5	5
9	0	0	0	0	0	0	0	9	0	0	0	0	0	8.5	4	9	0	2.5	0	2.5	0	8	4
10	0	0	0	0	0	0	0	10	0	1	4	5	0	8	1	10	0	3	0	3	0	7	3
11	0	0	0	0	0	0	0	11	0	1	6	7	0	8.5	4	11	0	4	0	4	0	9	7
12	0	0	0	0	0	0	0	12	0	2	2	4	0	5	2	12	0	0	0	0	0	10	2
13	0	0	0	0	0	0	0	13	0	1	6	7	0	8	8	13	0	0	0	0	0	8	9
14	0	0	0	0	0	0	0	14	0	1	6	7	0	11	3	14	0	3	0	3	0	9	6
15	0	0	0	0	0	0	0	15	0	1	6	7	0	10	6	15	0	0	3	3	0	9	3
16	0	0	0	0	0	0	0	16	0	1	6	7	0	10	7	16	0	0	6	6	0	9	3
17	0	0	0	0	0	0	0	17	0	1	4	5	0	10.5	11	17	0	0	5	5	0	8.5	5
18	0	0	0	0	0	0	0	18	0	0	0	0	0	12	7	18	0	0	5.5	5.5	2	9	4
19	0	0	0	0	0	0	0	19	0	0	0	0	0	11	11	19	0	0	4	4	0	9	5
20	0	0	0	0	0	0	0	20	0	1	1.5	2.5	0	10	8	20	0	0	6	6	0	9	7
21	0	0	0	0	0	0	0	21	0	7	0	7	0	10	4	21	0	0	6	6	0	5.5	3
22	0	0	0	0	0	0	0	22	0	1	4	5	0	9.5	7	22	0	0	6	6	0	11	7
23	0	0	0	0	0	0	0	23	0	7	0	7	0	9.25	4	23	0	0	4	4	0	11	6
24	0	0	0	0	0	0	0	24	0	3	0	3	0	5.5	4	24	0	0	6	6	0	8.5	4
25	0	0	0	0	0	0	0	25	0	0	0	0	0	8.5	3	25	0	0	1	1	0	9	8
26	0	0	0	0	0	0	0	26	0	4	0	7	0	10.5	5	26	0	0	4	4	0	8.5	6
27	0	0	0	0	0	0	0	27	0	0	0	0	0	9	4	27	0	0	0	0	0	9	7
28	0	0	0	0	0	0	0	28	0	6	0	6	0	2	3	28	0	0	3	3	0	10	4
29	0	0	0	0	0	0	0	29	0	6	0	6	0	9	4	29	0	0	1	1	0	9.5	5.5
30	0	0	6	6	0	2.5	1	30	0	4	0	4	0	11.5	3	30	0	0	3	3	0	5.5	5
								31	0	3	0	3	0	12	6	31	0	0	4	4	0	4.5	3

(4) July 2006

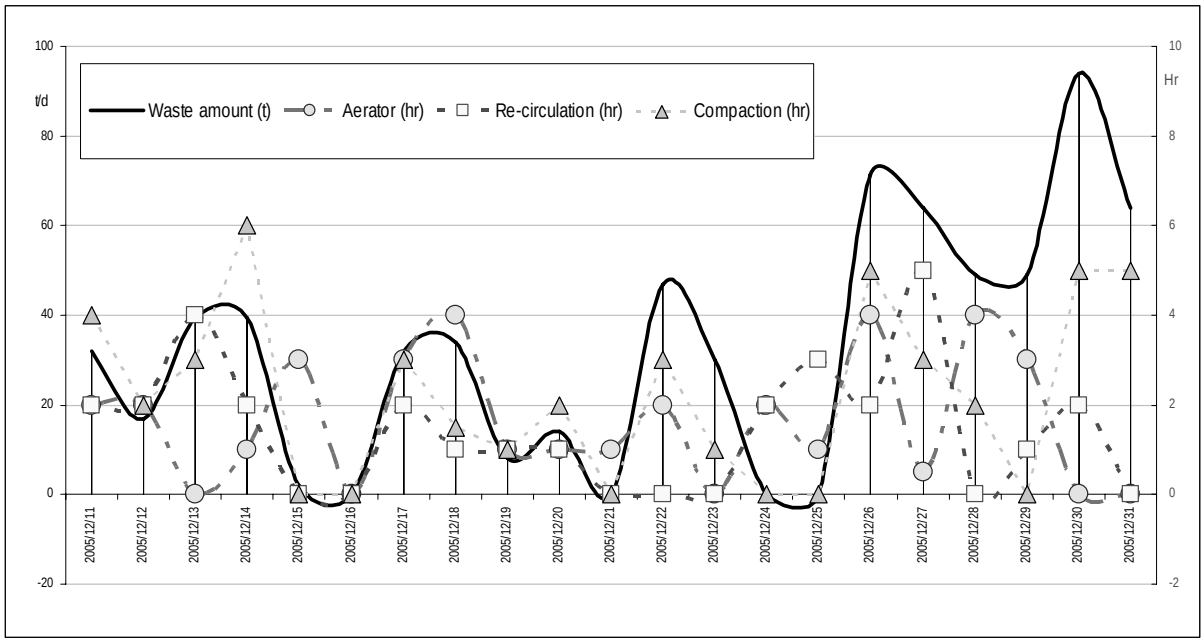
July	Operation Hours						
	Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compactor	Loader/ Excavator
1	0	0	4	4	0	4.5	3
2	0	0	5	5	0	3	5
3	0	0	3	3	0	5	4
4	0	0	4	4	0	8	4
5	0	0	4	4	0	6.5	3.5
6	0	0	4	4	0	2	6
7	0	1	4	4	0	6.5	5
8	0	0	4	4	0	2	6
9	0	0	0	0	0	3	0
10	0	0	0	0	0	10	0
11	0	0	0	0	0	4.5	2
12	0	0	0	0	0	8	0
13							
14							
15							
16							
17							
18							
19	0	0	0	0	0	7.5	0
20	0	0	0	0	0	8	3
21	0	0	0	0	0	10	0
22	0	0	0	0	0	2	6
23	0	0	0	0	0	7	6
24	0	0	0	0	0	11	0
25	0	0	0	0	0	3	6
26							
27							
28							
29							
30							
31							

(5) October, November and December 2006

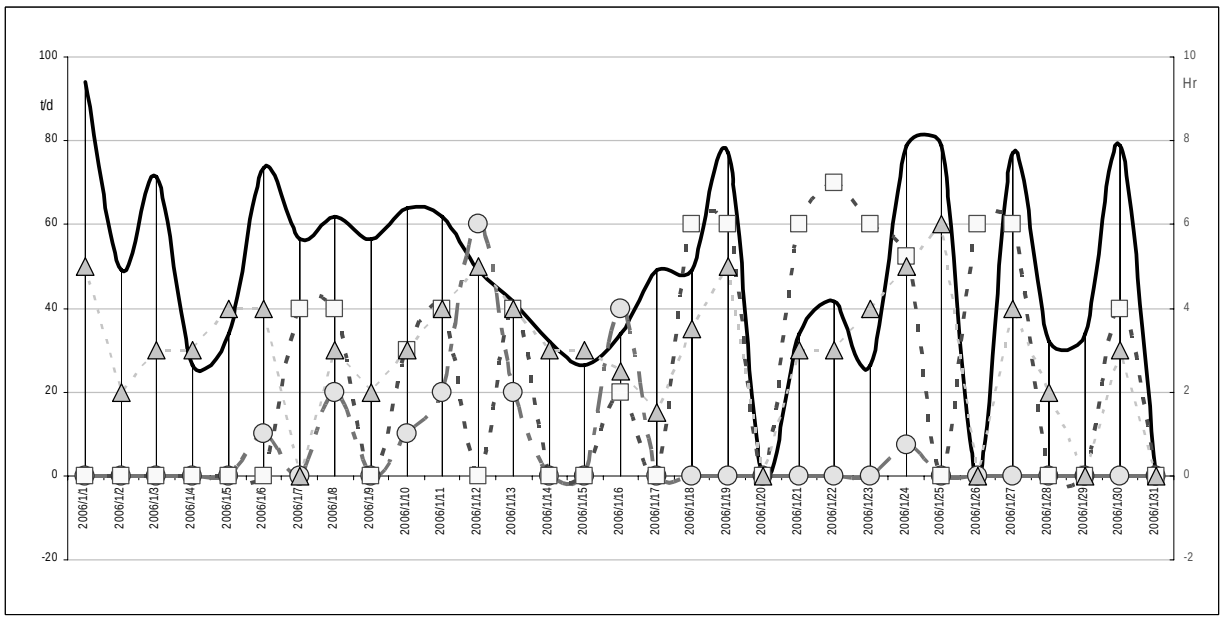
Oct	Operation Hours							Nov	Operation Hours							Dec	Operation Hours						
	Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compac	Loader/ Excavator		Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compac	Loader/ Excavator		Weighbridge	Aerator	Re-circulation	Generator 1 (PP)	Generator II	Bull dozer/Compac	Loader/ Excavator
1								1	0	0	4	4	0	6.5	6.5	1	0	0	5	5	0	14	5
2								2	0	0	4	4	0	2	9	2	0	0	6	6	0	13	6
3								3	0	1	4	4	0	6.5	9	3	0	0	1.5	1.5	0	14	9
4								4	0	0	4	4	0	2	12	4	0	0	0	0	0	13.5	4
5								5	0	0	5	5	0	3	12	5	0	0	1	1	0	10	5
6								6	0	0	3	3	0	5	9	6	0	0	0	0	0	13	5
7								7	0	0	4	4	0	8	10	7	0	0	5	5	0	5	6
8								8	0	0	4	4	0	6.5	9.5	8	0	1	2	2	0	6.5	3
9								9	0	0	4	4	0	2	11	9	0	0	5	5	0	3	4
10								10	0	1	4	4	0	6.5	10	10	0	0	3.5	3.5	0	15.5	6
11								11	0	0	4	4	0	2	10	11	0	0	5	5	0	9	5
12								12	0	0	5	5	0	3	11	12	0	0	3	3	0	7	4
13								13	0	0	3	3	0	5	12	13	0	0	2.5	2.5	0	9	5
14								14	0	0	4	4	0	8	11	14	0	0	1.5	1.5	0	6.5	5
15	0	0	5	5	0	0	0	15	0	0	4	4	0	6.5	8.5	15	0	1	0	1	0	4	5
16	0	0	3	3	0	5	4	16	0	0	4	4	0	2	12	16	0	0	4	4	0	3	2
17	0	0	4	4	0	0	0	17	0	1	4	4	0	6.5	12	17	0	0	0	0	0	8	6
18	0	0	4	4	0	6.5	11.5	18	0	0	4	4	0	2	10	18	0	0	4	4	0	9	7
19	0	0	4	4	0	2	14	19	0	0	5	5	0	3	12	19	0	0	6	6	0	8	5
20	0	0	0	0	0	0	4	20	0	0	3	3	0	5	10	20	0	0	0	0	0	9	6
21	0	0	4	4	0	2	11	21	0	0	4	4	0	8	11	21	0	0	0	0	0	8.5	6
22	0	0	5	5	0	3	10	22	0	0	4	4	0	6.5	9.5	22	0	0	0	0	0	8	4
23	0	0	3	3	0	5	9	23	0	0	4	4	0	2	13	23	0	0	0	0	0	4	0
24	0	0	4	4	0	8	4	24	0	1	4	4	0	6.5	10	24	0	0	0	0	0	7.5	2
25	0	0	4	4	0	6.5	7.5	25	0	0	4	4	0	2	6	25	0	0	0	0	0	10	8
26	0	0	4	4	0	2	11	26	0	0	0	0	0	6	5	26	0	0	0	0	0	7	0
27	0	1	4	4	0	6.5	13.5	27	0	0	1	1	0	6	5	27	0	0	0	0	0	4	6
28	0	0	4	4	0	2	10	28	0	0	0	0	0	2.5	6	28	0	0	0	0	0	9	6
29	0	0	5	5	0	3	10	29	0	0	1	1	0	16	7	29	0	0	0	0	0	2	0
30	0	0	5	5	0	3	10	30	0	0	2	2	0	8	6	30	0	0	0	0	0	8	4
31	0	0	4	4	0	8	9									31							

J-4 Waste Arrivals Graphs

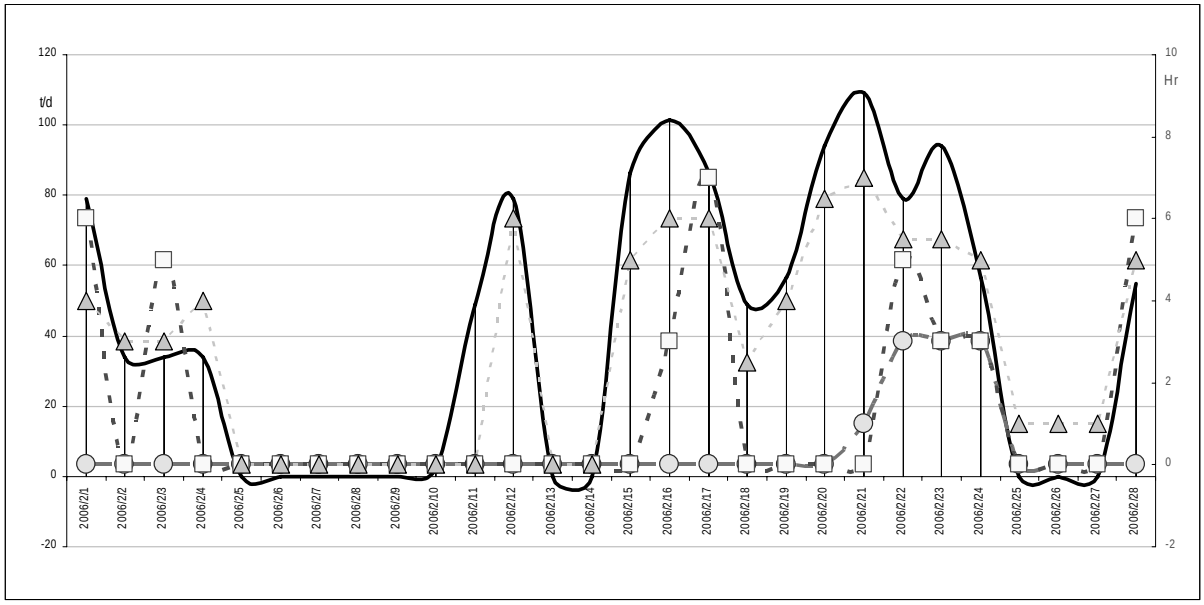
December 2005



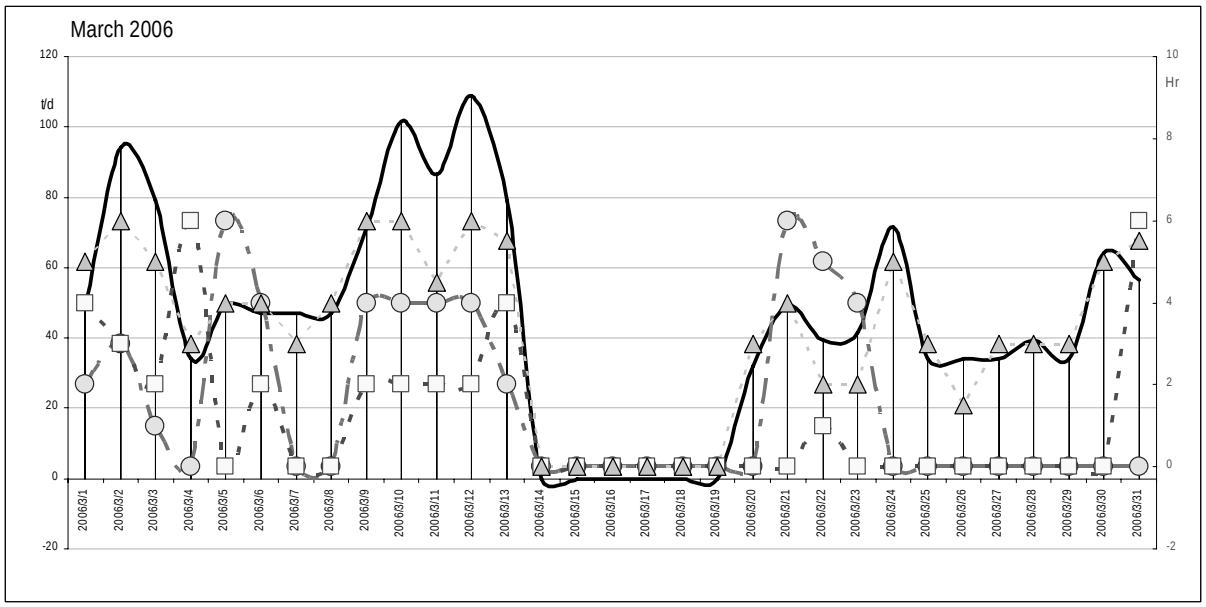
January 2006



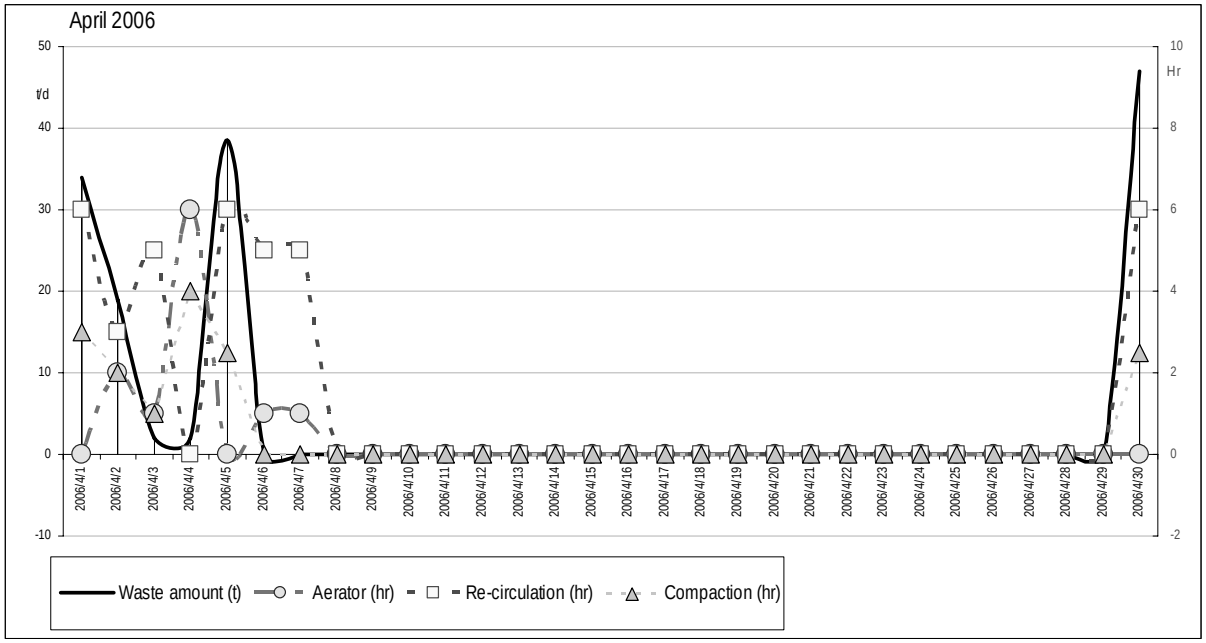
February 2006



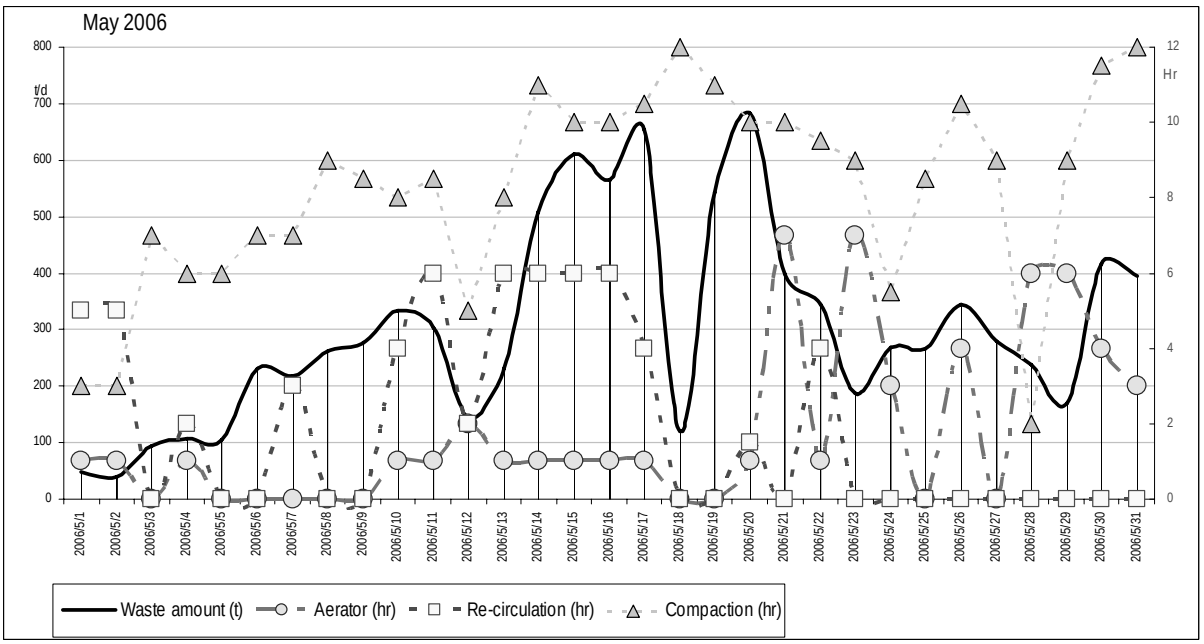
March 2006



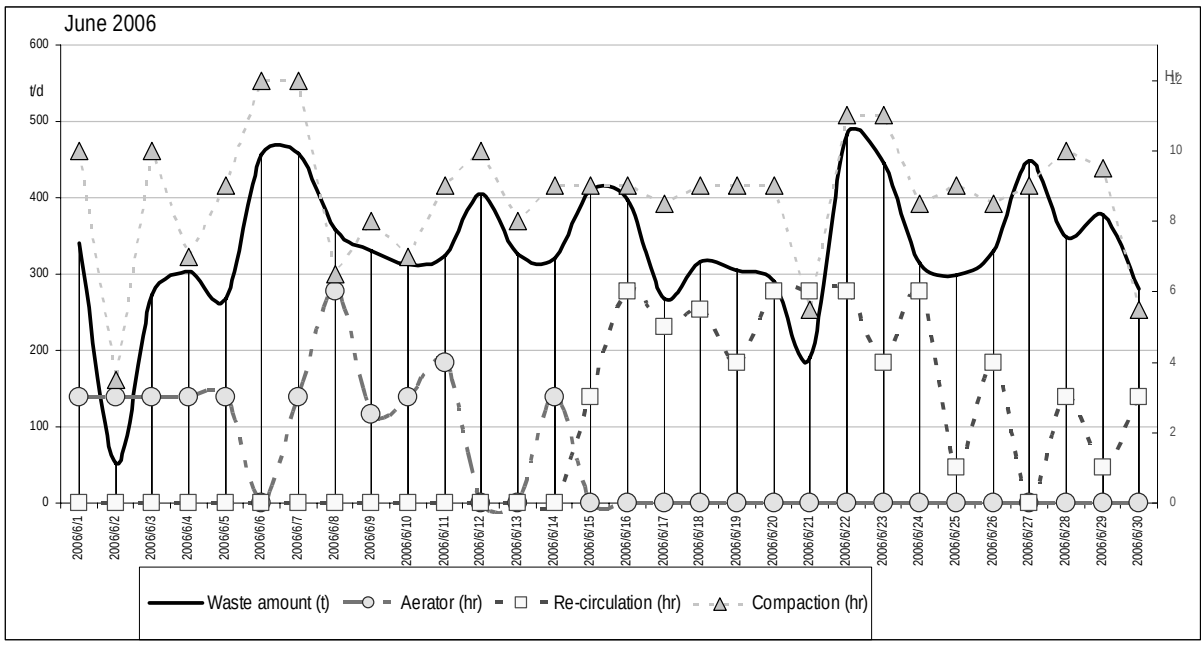
April 2006



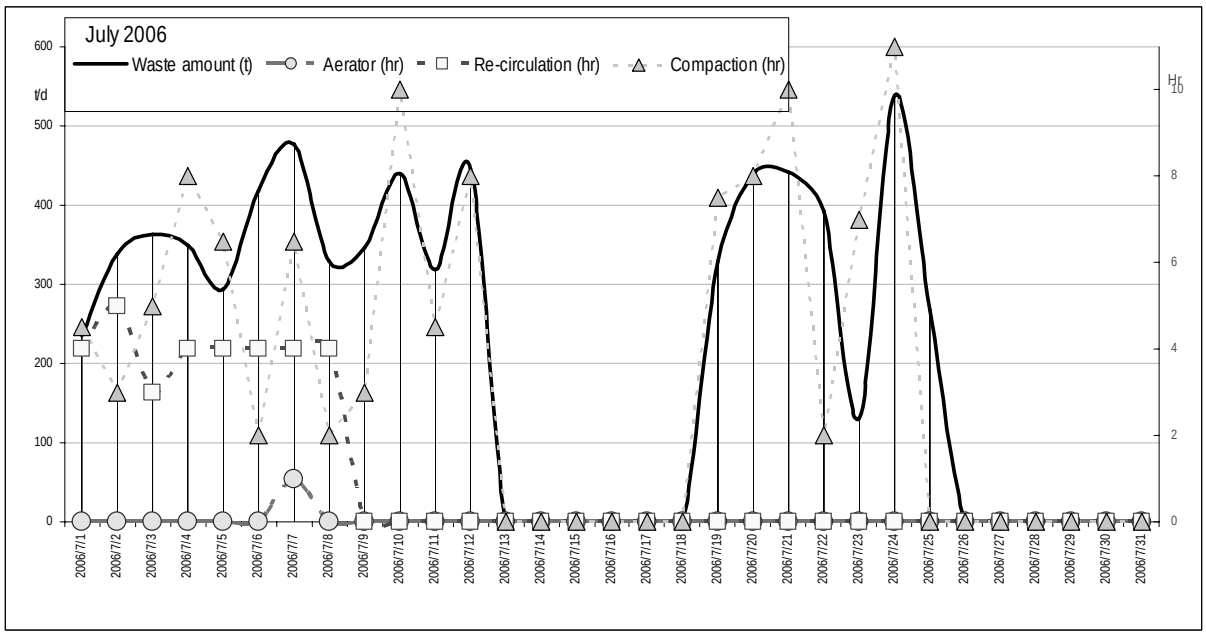
May 2006



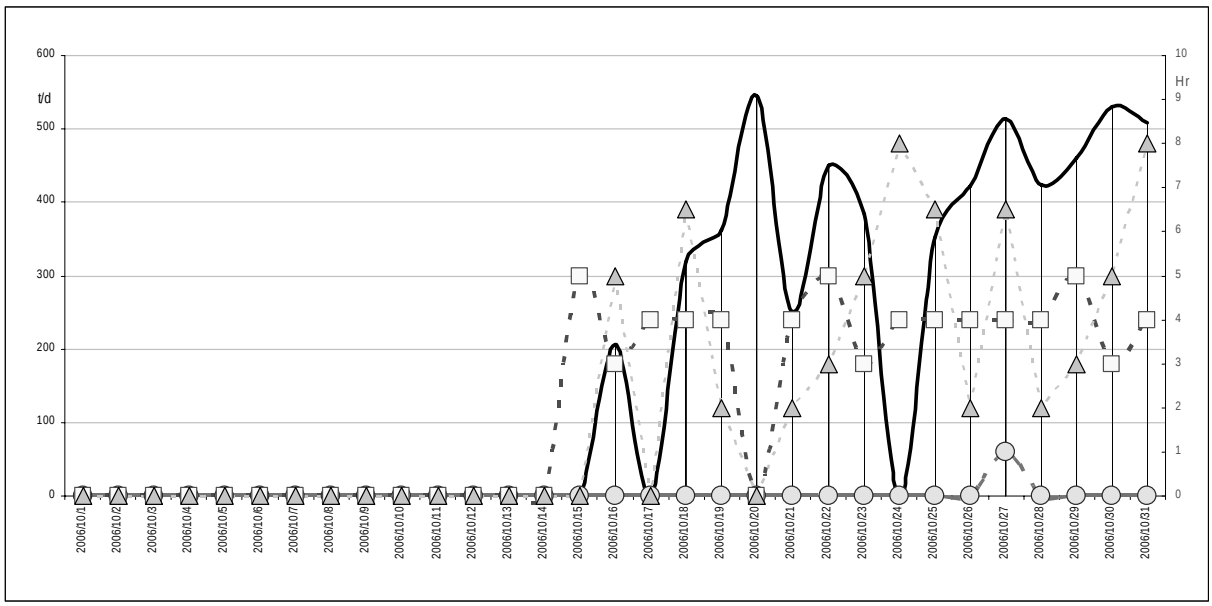
June 2006



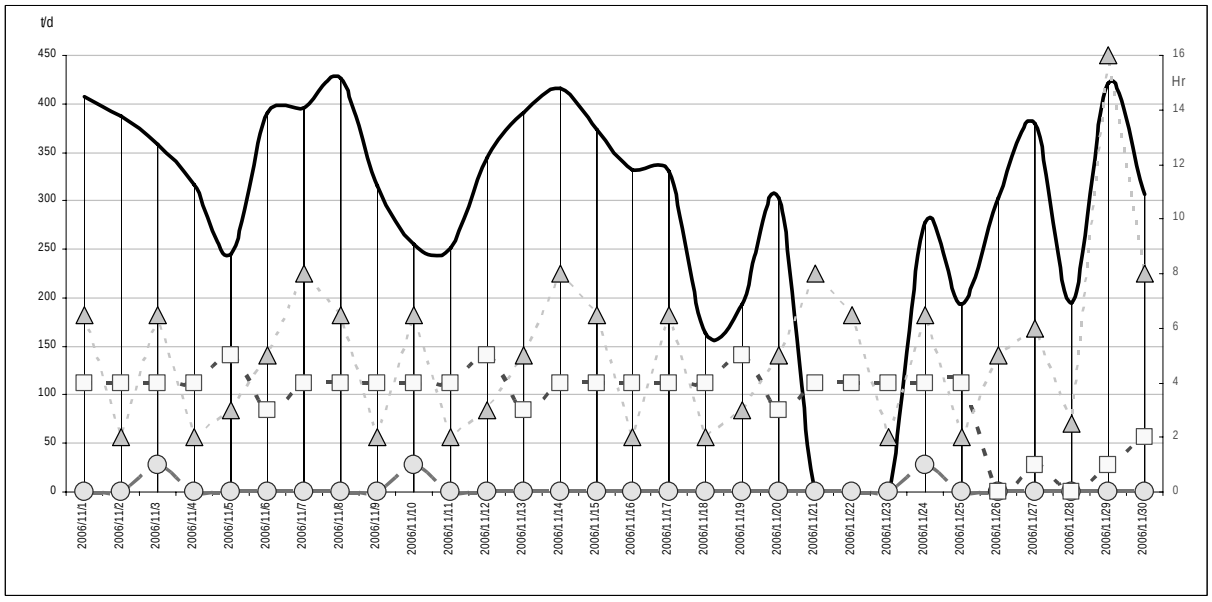
July 2006



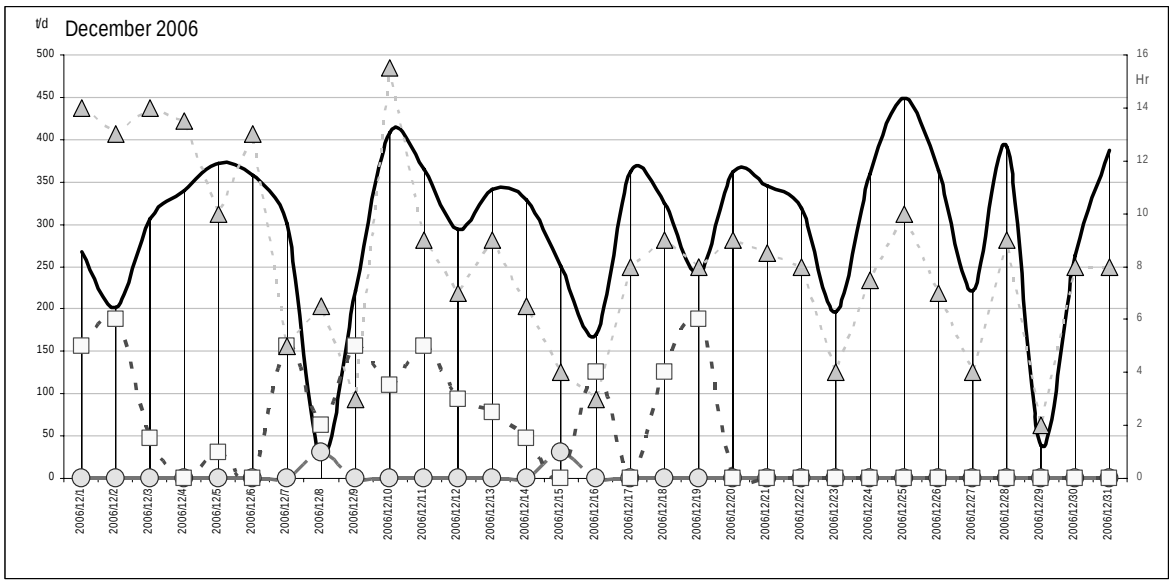
October 2006



November 2006



December 2006



J-5 Water Quality Monitoring

(1) Sampling

To date, water samples have been taken on ten different dates from the Kalpu Khola River running south of Sisdol S/T-LF, the boreholes downstream of Valleys 1 and 2 and the leachate generated from the disposed wastes. The first four samplings were performed on dates before the operation commenced. The locations of these tests are shown in the figure below. The water samples for dissolved oxygen (DO) and remaining parameters were collected in separate bottles, and were packed in icebox and brought to the laboratory same day.

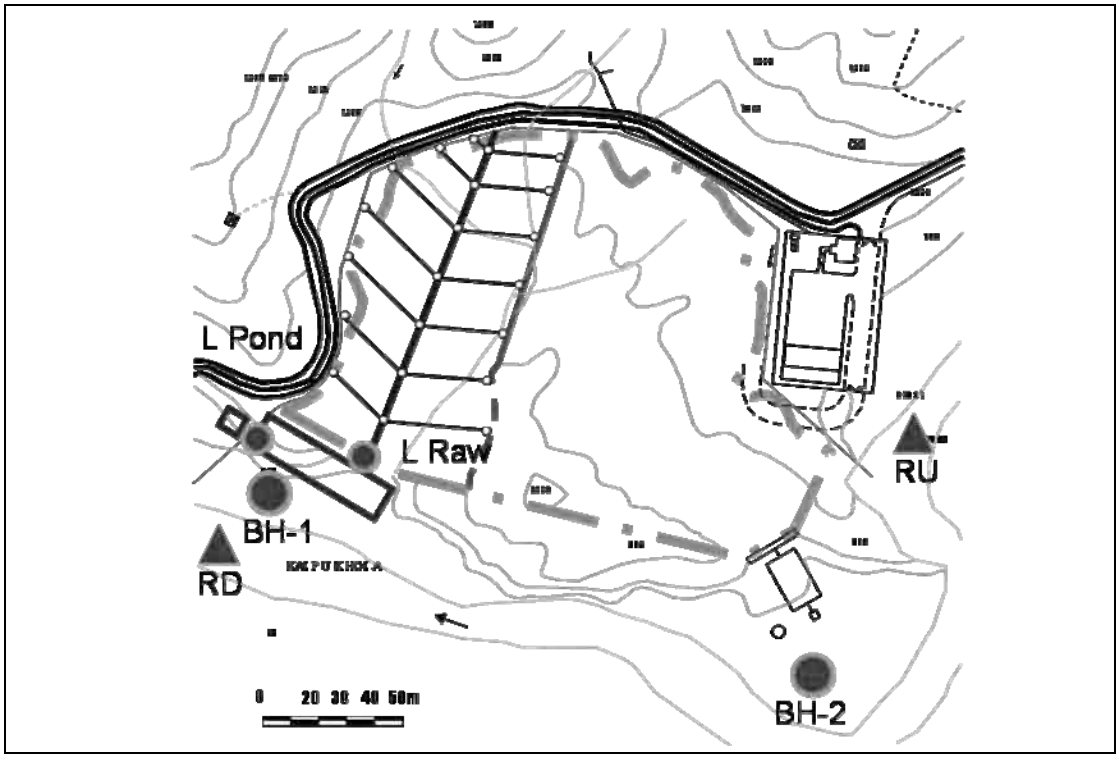


Figure Locations of Water Sampling

(2) Methods and Equipment

The parameters measured in the filed, methods and equipments used there are shown in the table below.

Table Equipments Used in the Field for Water Quality Monitoring

Parameter	Method	Equipment
Climate	Field observation	-
Air temperature	-	Thermometer
Water temperature	-	Thermometer
Color	Visual	-
Turbidity	-	Turbidity Tube
pH	-	pH meter
Odor	Smell	-
Groundwater level	Piezometric	Piezometer

The parameters analyzed in the laboratory, methods and equipments used there are shown in the table below.

Table Equipments Used in the Laboratory for Water Quality Monitoring

Parameter	Method	Equipment
DO	Titration (Alkali-Iodide Azide modification)	-
EC	Potentiometric	Conductivity meter
TSS	Gravimetric (filtration and weighing of residue)	Scaletec, SBA 32, Max. 120 kg, d = 0.0001g
BOD	5 days incubation at 20°C and titration of initial and final dissolved oxygen	Incubator Kottermann, 2771
COD	Dichromate Oxidation & Titration with ferrous ammonium sulphate	COD digestion unit
Ammonia	Spectrophotometric (Phenate method)	Perkin Emler, Lamda EZ 150, USA

(3) Results of Water Quality Monitoring

The results of water quality monitoring are shown in the table below.

Table Results of the Groundwater and River Water (December 2006)

15th Dec 2006 Sisdol LFS Data

		Borehole 1	Borehole 2	Kolpu upstream	Kolpu downstream
Air Temperature	oC	16	14	14	15
Water Temperature	oC	22	19	11	11
Odor	_	Light decaying odor	Decaying odour	Muddy	Muddy
Groundwater level from surface	m	2	3.3	_	_
Color		Light grey	Light grey	yellowish brown	Yellowish brown
Turbidity	NTU	75	400	800	750
pH	-	6.80	6.61	7.68	7.78
Chloride	mg/L	34	34	65	68
Electrical Conductivity	uS/cm	797	285	91	97
Dissolved Oxygen (DO)	mg/L	0	2.00	9.00	9.70
Biochemical Oxygen Demand (BOD)	mg/L	50.00	46.00	10.00	9.60
Chemical Oxygen Demand (COD)	mg/L	85.69	69.10	34.53	35.36
Ammonia- Nitrogen (NH_4-N)	mg/L	NA	NA	1.10	0.87

Source: JICA Study Team

Table Summarized Results of the Water Quality Analysis

1. RIVER	MOPE	2004/7/27		2005/3/1		2005/3/20		2005/5/24		2005/6/9		2005/6/28		2005/7/21		2006/1/24		2006/3/5		2006/6/8	
	Std	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD	RU	RD
Water temperature (°C)		23	23	17	18	20	19			29	29	26	27	24	22	8	9	13	14	24	24
pH	5.5-9.0	7.6	7.4	7.9	8.3	7.8	8.1			8.9	8.4	7.4	7.9	7.2	7.6	7.69	7.67	7.65	8.15	7.71	7.88
Dissolved Oxygen (DO; mg/L)		7.3	7.1	9.5	9.1	7.8	8.4			7.4	7.9	7.5	7.5	8.4	8.0	10.5	10.5	10.5	10.1	8.4	7.5
Tot. Suspended Solids (TSS; mg/L)	30-200	NA	NA	53	93	43	87			3	3	26	3	73	474	NA	NA	NA	NA	NA	NA
Biochemical Oxygen Demand (BOD; mg/L)	30-100	15	17	4	7.2	1.1	1			2	2	6	5	15	16	4	11	5	5	3	6
Chemical Oxygen Demand (COD; mg/L)	250	24	21.8	25	19.5	22.5	20			12	3	15	23	30	39	6	12	7	7	29	30
Ammonia-Nitrogen (NH_4-N)	50	1	3.7	0.6	0.7	1.1	1			0.2	0.3	0.4	0.4	0.4	0.5	0.77	0.49	0.81	0.75	0	0
2. GROUNDWATER		2004/7/27		2005/3/1		2005/3/20		2005/5/24		2005/6/9		2005/6/28		2005/7/21		2006/1/24		2006/3/5		2006/6/8	
		BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2	BH1	BH2
Water temperature (°C)		23	24	21	20	22	23	22	23	30	31	29	29	28	28	18	18	19	19	23	24
pH	5.5-9.0	7.3	7.4	7.6	6.7	7.5	6.5	6.3	6.2	6.3	6.3	6.7	6.4	7	6.3	7.38	6.43	6.94	6.4	6.65	6.57
Dissolved Oxygen (DO; mg/L)		4.9	6.5	4.5	1.8	4	4.1	5.2	3.4	3.6	4.6	3.7	6.8	2.3	5.6	6	4.5	7.5	5	5	5
Tot. Suspended Solids (TSS; mg/L)	30-200	465	1,936	334	27,524	213	9,079	76	484	36	145	4	87	164	40	NA	NA	NA	NA	NA	NA
Biochemical Oxygen Demand (BOD; mg/L)	30-100	25	30	17.5	420	12.5	80	3	17	10	9.4	7	11	9	25	21.5	11.5	8	35	17	31
Chemical Oxygen Demand (COD; mg/L)	250	119.9	127.7	44.5	980	43	250	18	34	12.5	20.5	20	40	70	41	107.7	109.4	25.98	62.64	58.24	166.4
Ammonia-Nitrogen (NH_4-N)	50	0.6	18	1.1	0.7	2.3	3.5	5.3	0.5	0.4	0.5	1.2	0.8	0.4	0.6	0.94	1.16	1.12	1.32	1.12	1.17
3. LEACHATE		2004/7/27		2005/3/1		2005/3/20		2005/5/24		2005/6/9		2005/6/28		2005/7/21		2006/1/24		2006/3/5		2006/6/8	
		L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond	L Raw	L Pond
Water temperature (°C)										23	35	24	27	26	25	15	15	22	17.5	32	29
pH	5.5-9.0									7.0	6.9	5.5	5.7	5.6	5.6	7.7	7.8	7.6	7.9	6.5	7.5
Dissolved Oxygen (DO; mg/L)										2.4	2.8	ND	ND	ND	ND	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Suspended Solids (TSS; mg/L)	30-200									62	364	870	840	13,280	14,010	567	965	475	1,000	1,550	6,930
Biochemical Oxygen Demand (BOD; mg/L)	30-100									333	2,100	7,750	5,750	27,000	13,800	3,400	6,700	6,400	8,975	69,000	32,500
Chemical Oxygen Demand (COD; mg/L)	250									525	2,675	11,625	7,900	44,500	25,500	4,664	7,632	10,857	13,270	104,000	43,680
Ammonia-Nitrogen (NH_4-N)	50.0									6.9	9.6	321.4	125.7	144.7	97.3	653.4	612.3	693.6	471.6	996.3	501.1

Source: JICA Study Team

J-6 Tracer Test in Sisdol Short-term Landfill

(1) Purpose

The tracer test was implemented to clarify whether the leachate collection pipe (main) has been choked or not. The tests were implemented on August 17 and 24, 2006.

(2) Method

The several gas ventilation pipes were selected and the distance was measured between the selected gas ventilation pipes and the outlet of main leachate collection pipe. The colored water was poured into the mouth of selected gas ventilation pipes and the changes of color of leachate were observed and also travel times were measured until that the colored water arrived at the exit of the main pipe (discharge point to the leachate retention pond). The drainage condition of leachate collection pipe was grasped by comparing between the design velocity and the actual velocity.

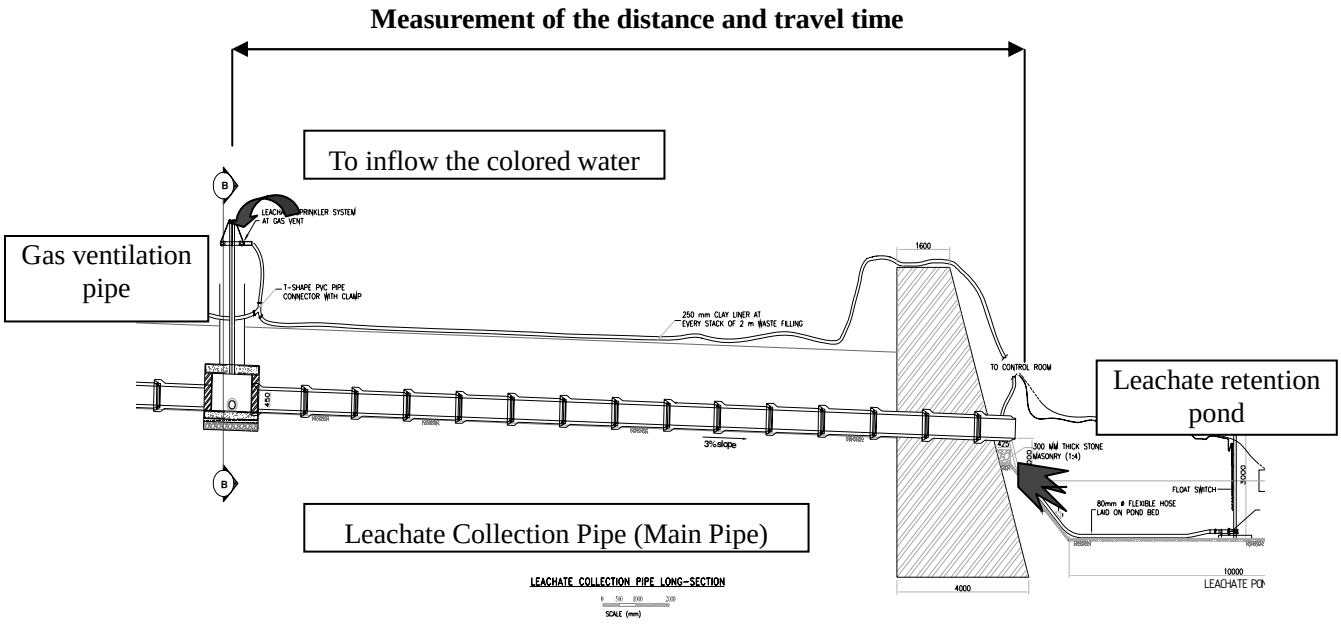
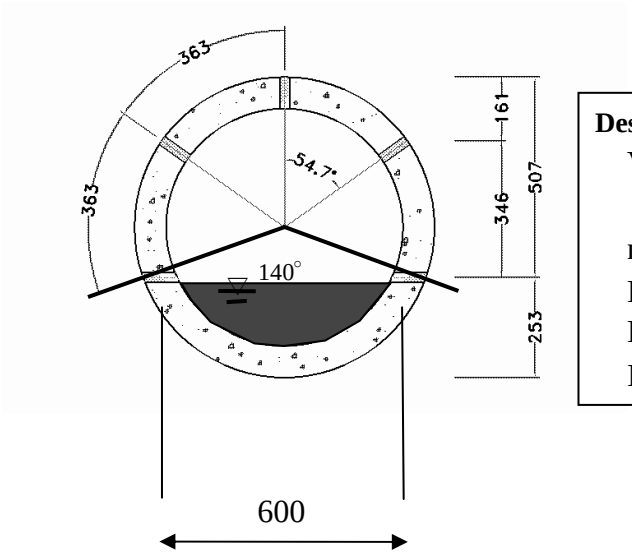


Figure 1 Test Method



Design Velocity (Manning Formula)

$V=1/n \times R^{2/3} \times I^{1/2}$

$=1/0.013 \times 0.11^{2/3} \times 0.03^{1/2}$=**3.0m/s**

n: Roughness coefficient (=0.013)

R: Hydraulic radius (m) (=A/P=0.08/0.73=0.11m)

P: Wetted perimeter (m) (=R$\times \pi \times$140/360=0.73m)

I: Slope (=3%)

Figure 2 Design Velocity of Leachate Collection Pipe

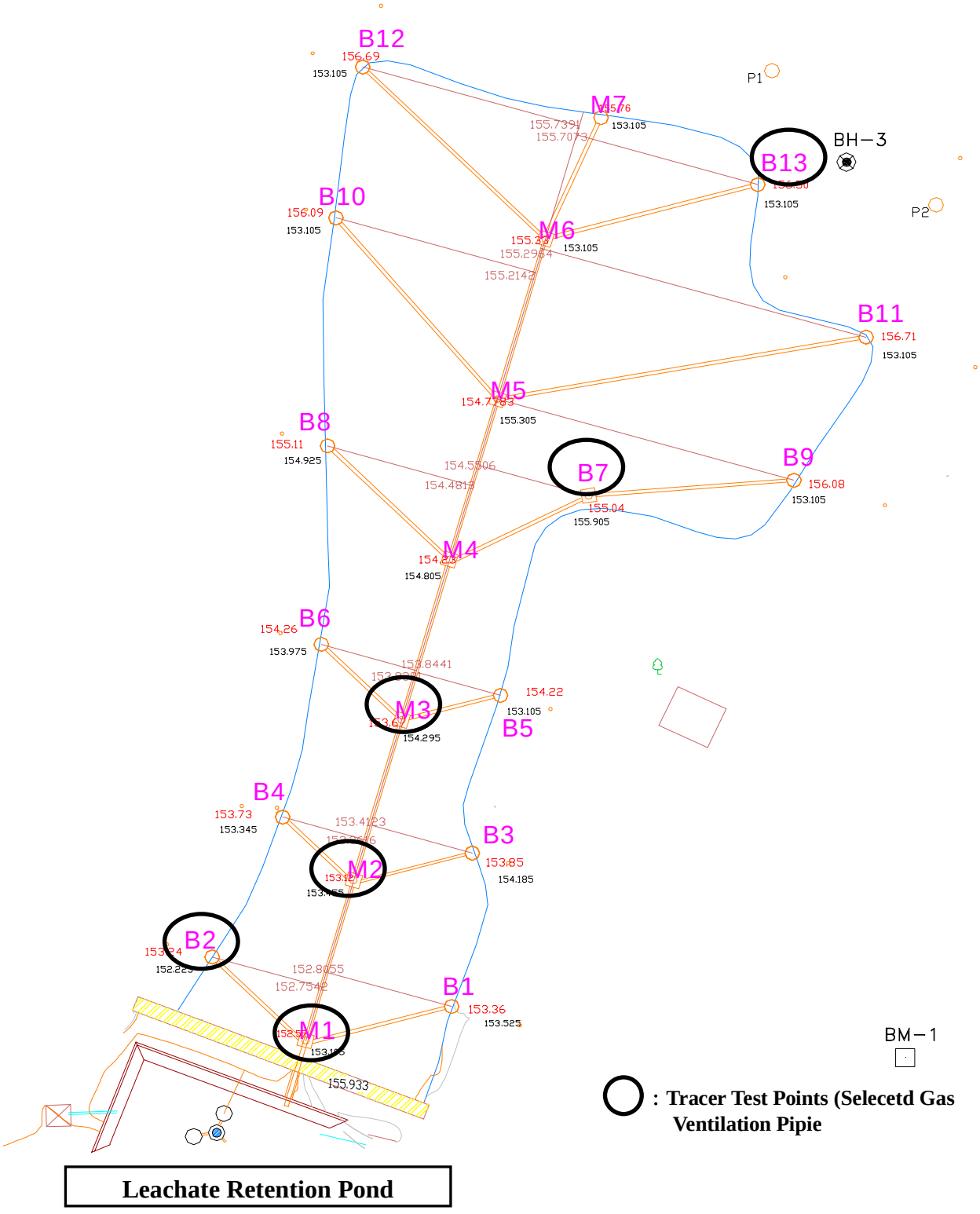


Figure 3 Leachate Collection Pipe, Gas Ventilation Pipe and Tracer Test Points (Selected Gas Ventilation Pipes)

(3) Result of the Tracer Test

The colored water poured into the gas ventilation pipes was confirmed at the exit of the main leachate collection pipe on the all tests. When the colored water poured in the pipes with the longer distance from the exit of main collection pipe, the lighter colored water was observed at the exit. This fact revealed that there were leachate inflows from surrounding areas to main leachate collection pipe. From the above results, it was concluded that the leachate collection pipe was not choked and there was a little possibility that leachate retained inside of the landfill site.

On the other hand, the observed velocity of leachate (colored water) was slower than the design one. It was considered that the leachate (colored water) took time to travel for the inclined gas ventilation pipe, and earth and soil accumulated in the main pipe might obstacle the leachate flow more or less.

Table Result of Tracer Test

Gas Ventilation Pipe No.	Date	Travel Time (Gas Ventilation Pipe – Exit)	Distance (Gas Ventilation Pipe - Exit)	Observed Velocity (Distance / Time)	Design Velocity	Color Intensity of Leachate (Exit)
M1	24th August	16 sec.	8.5 m	0.5m/s	3.0m/s	Very deep
M2	24th August	60 sec.	26 m	0.4m/s		Deep
B2	24th August	79 sec.	20 m	－		Light
B7	24th August	180 sec.	71 m	－		Very light
M3	17th August	90 sec.	43 m	0.5m/s		Light
B13	17th August	420 sec.	122.5 m	－		Very light

Note: The velocities were measured in the leachate collection main pipe only.

Photo 1 Leachate at the Exit of Main Collection Pipe before Tracer Test

Photo 2 Pouring Colored Water into the Gas Ventilation Pipe

Photo 3 Colored Water Observed at the Exit of Main Collection Pipe

Supporting Report K

Operation Manual

for Sisdol Short-term Landfill (Valley 1)

OPERATION MANUAL

Sisdol Short-term Landfill (Valley 1)

March 2007

Table of Contents

CHAPTER 1 INTRODUCTION

1.1 Semi-aerobic System

The disposal of the waste should be implemented in a sanitary manner in order to protect the public health and mitigate impacts on the environment.

Decomposition of the disposed solid waste, and in particular organic content requires time. Although the organic matter may decompose under either aerobic or anaerobic conditions, in the case of sanitary landfills, decomposition under anaerobic condition is most common.

Anaerobic decomposition of organic matter produces methane and water, decomposition is slow and leachate content is large. On the other hand, under aerobic decomposition organic matter decomposes into carbon dioxide and water and decomposition is rapid. Aerobic decomposition requires a supply of oxygen to be pumped into the landfill. This is a costly system both in terms of construction and maintenance.

At the sanitary landfill, decomposition of the organic matter will increase the temperature in the waste layers. Under semi-aerobic sanitary landfill system, as the collected leachate leaves the outlet pipe (to discharge into the leachate pond), which is suspended above the leachate level and ***not submerged in the leachate***, air is sucked into the sanitary landfill through the gas removal pipes and the leachate collection pipes with large diameters consequently creating a semi-aerobic system. Specifically the following process is observed:

a. Parts of the landfill in the vicinity of the pipes are under aerobic conditions
b. The differential temperature in the landfill create natural ventilation and the supply of air to the landfill
c. The leachate quality improves within a quick time.

The semi-aerobic system is schematically presented in Figure 1.1.

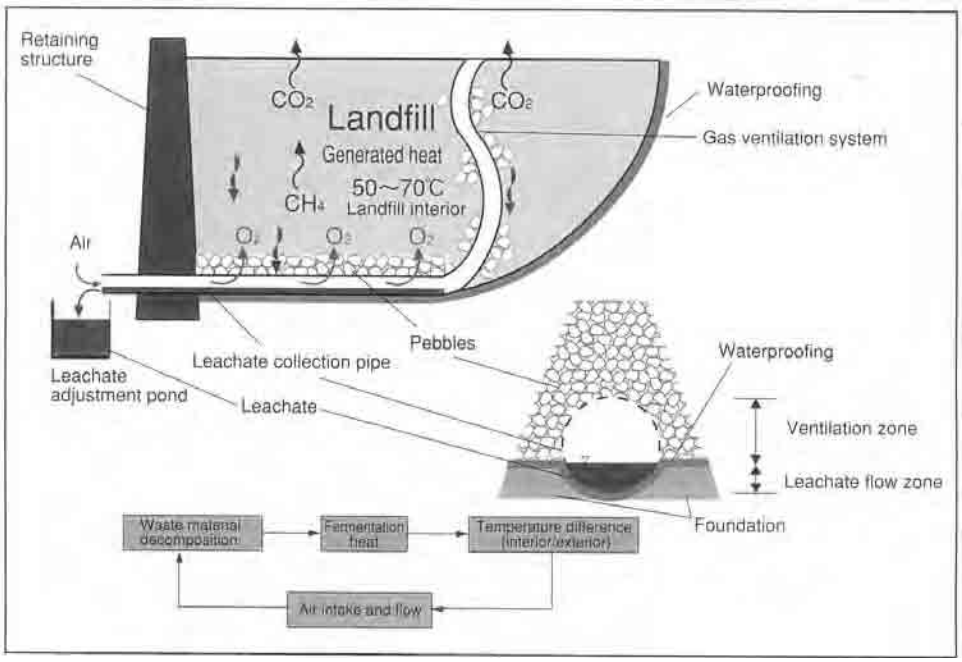


Figure 1.1 Schematic Presentation of Semi-aerobic Landfill System

Source: Fukuoka City

1.2 Landfill Development Levels

In past JICA studies in other developing countries four (4) landfill levels have been identified. These are described in Table 1.1. For long term landfill sites Level 4 offers the best countermeasures for mitigation of impacts on the environment and therefore it is proposed that the Nepal decision makers aim to achieve that level.

Sisdol short term landfill will be operated for only 3-4 years and therefore application of natural liner and leachate re-circulation with aeration treatment was adopted. This level is midway between Levels 3 and 4.

Table 1.1 Proposed Sanitary Landfill Levels

Facility	Level 1	Level 2	Level 3	Level 4
Description	Controlled tipping	Sanitary LF with bund and daily cover	Sanitary LF with leachate re-circulation	Sanitary LF with leachate treatment facilities
Soil cover	O (Periodic)	O	O	O
Embankment		O	O	O
Drainage facility		O	O	O
Gas venting		O	O	O
Leachate collection			O	O
Leachate re-circulation			O	O
Leachate treatment				O
Liners				O

1.3 Project Beneficiaries

The Sisdol Short-term Landfill is used to dispose of the municipal solid waste collected from KMC, LSMC and KRM. In addition solid waste collected from the adjacent VDCs may be disposed of at the site.

The Local Committee and Operator should discuss means by which the waste generated in the site surrounded area may be brought to the LF for disposal. The Operator may assist in the collection of waste brought to collection points at Tinpiple and along the access road to the site.

The Sisdol Short-term Landfill is expected to assist in determining the suitability of the semi-aerobic landfill system in the context of the Nepali SWM. Therefore SWM stakeholders will also benefit from this site.

In terms of regional development, the sanitary landfill and its associated infrastructures (approach road, electricity supply, water supply, telephone lines, etc.) are expected to benefit the region's development as a whole. The landfill will also provide employment opportunities.

CHAPTER 2 PURPOSE OF THE MANUAL

2.1 Scope of the Manual

The scope of this Operations Manual is as follows:

1) Provide guidance on the sharing of responsibilities amongst the various related stakeholders
2) Provide information on the basic components of the landfill designed and constructed
3) Familiarize the Operator with the various containment units and environmental control/ monitoring systems
4) Familiarize the Operator with the general operational phasing of sequencing of waste filling
5) Provide basic information on the type and purpose of the landfill heavy equipment
6) Provide instructions on daily waste filling operations including load inspection procedures, spreading and compaction of waste and application of cover
7) Provide procedures for operating under inclement or wet weather conditions
8) Provide procedures for emergency response and management
9) Provide detailed description on environmental monitoring and inspections
10) Familiarize the Operator with safety procedures related to landfill operations

2.2 Limitations

This manual was prepared in accordance with basic standard practices in the operation of modern sanitary landfills of this level, specifically practices employed in operation of semi-aerobic landfills in Japan and developing countries.

The operation of landfills in Japan is strictly regulated and therefore standards applicable there were referred to in this manual. However some facilities included in landfills operating in Japan for dealing with waste characteristics of Japan[1] were not included at this site. For that reason the practices developed and adopted in developing countries in south-east Asia[2] were also referred to.

The manual does not provide specific procedures in other areas of SWM such as equipment maintenance and repair, handling of toxic and hazardous waste, detailed safety procedures, and detailed emergency response. It is intended to provide the Operator with the basic knowledge and understanding of landfill operation in general.

[1] Municipal waste disposed of in Japan is mostly ash generated from the incineration of the waste.
[2] Practices in Malaysia where a semi-aerobic system has been introduced on some sites were referred to.

CHAPTER 3 ORGANIZATIONAL STRUCTURE OF THE LANDFILL OPERATION

3.1 Organizational Structure

This site has been developed by SWMRMC and that organization is expected to continue to develop Valley 2 of the landfill as well as the facilities related to the final closure of the site. KMC and LSMC will dispose of their municipal solid waste here and shall be responsible for the site operation. KRM is also expected to dispose its waste at Sisdol LF, however due to its small waste amount; KRM should not be burdened with the site operation responsibility. KMC and LSMC will be referred to hereafter in this guideline as the "Operator". Therefore these three agencies (SWMRMC, KMC and LSMC) are expected to fully share responsibility for the site further development, operation and post-closure management. The sharing of responsibilities can be broadly defined as shown in the following table.

ACTIVITIES	SWMRMC	KMC	LSMC
Development	- Valley 2 - Closure facilities - Regional development		
Operation	- Environmental monitoring	- Waste disposal operation - Development associated with operation - Support to environmental monitoring	
Post Closure Management	- Development works associated with final landfill closure (such as final capping, permanent storm water drainage system, etc.) - Operation and maintenance - Environmental monitoring		

Regardless of the waste amounts sent by each of the two cities to Sisdol LF, both cities shall be jointly and equally responsible for the operation of landfill in a sanitary manner. Likewise SWMRMC, as the site developer will have a responsibility for the present and future site facilities in order to ensure that the Operator can with the efficient operation of the site ensure that the sanitary landfill conditions are maintained.

3.2 Sisdol LF Working Group

A Working Group (W/G) shall be formed by KMC, LSMC and SWMRMC and shall assume overall responsibility for the sanitary landfill operation. The W/G shall have the following specific responsibilities:

1) Review the Sanitary LF daily operation records and ensure that they are in order in terms of waste being accepted at the site, and presence of sufficient staff, heavy equipment and budget to effectively operate the site
2) Review any public complaints or comments on the sanitary LF operation and ensure that effective measures have been taken to deal with these complaints
3) Participate in the environmental monitoring process
4) Participate in meetings with the Local Committee, Okharpauwa Sanitary Landfill Site Main Coordination Committee (OSLSMCC) as necessary
5) Review the sanitary LF operation expenditures and prepare the budget
6) Manage issues related to landfill operations within their respective organizations and

coordinate with other related departments/sections
7) Provide technical advice and guidance to the permanent landfill staff
8) Hiring of the permanent landfill staff and evaluation of their work performance
9) Others as may be deemed necessary by the W/G

The Working Group shall, in order to discharge their duties as indicated above, hold weekly meetings and members shall visit the site at least once every two weeks.

3.3 Permanent Site Staff

A permanent staff shall operate the site. Although both KMC and LSMC shall provide the required personnel, the sanitary LF permanent staff shall operate as one team under the direct instructions of the site manager.

The minimum required staffing and their duties are outlined as follows:

(1) Landfill Manager
- Manage the landfill staff and assume responsibility for their safety
- Report to the W/G
- Prepare the budget and review the expenditures
- Manage the leachate aeration and re-circulation system and leachate pond
- Be responsible for environmental monitoring and participate in environmental coordination committee activities
- Maintain contact with the local community
- Others as directed by the W/G

(2) Asst. Manager/ Weighbridge Operator
- Maintain a daily record of the incoming waste
- Random check of incoming waste
- Develop the disposal plan and waste cell preparation, including the survey works for the setting of the waste heights based on the detailed design
- Maintain the operations expenditures accounts
- Maintain the daily operation records
- Others as directed by Landfill Manager

(3) Overseer
- Direct the waste trucks to the disposal cell
- Manage the heavy equipment operations
- Daily soil cover application
- Spraying of insecticides and odor suppressants
- Preparation of new waste disposal cell
- Others as directed by Landfill Manager or Assistant Manager

(4) Assistants (4 staff)
- Assist the Overseer
- Assist in mechanical works
- Assist heavy equipment operations
- Clear litter scattered away from waste disposal area
- Others as directed by Site Manager or Assistant Manager

(5) Public Relations Officer
- Compilation and analysis of public complaints or comments

- Liaison with surrounding community residents
- Prepare and disseminate information on site operation
- Arrange site explanatory visits
- Others as directed by Site Manager or Assistant

(6) Mechanic

- Daily inspection of heavy equipment, aerators and pumps and maintain maintenance records
- Simple repair and maintenance works
- Maintain sufficient spare parts on site for simple repairs
- Maintain records of heavy repairs and maintenance works carried out on equipment
- Others as directed by Site Manager or Assistant Manager

(7) Heavy Equipment Operators (3 staff)

- Operation of the heavy equipment under the direction of the Overseer
- Daily inspection of heavy equipment
- Assist in simple repair and maintenance works
- Others as directed by Site Manager, Assistant Manager or Overseer

(8) Guards (2 staff)

- Landfill access control
- Protection of landfill facilities and equipment
- Others as directed by Site Manager or Assistant Manager

The Sisdol LF operation shall commence with 14 permanent staff. As the waste amount disposed at the site increases and based on the experience gained the number, title and job descriptions of the staff may be amended based on request of the Site Manager and agreement of the W/G.

CHAPTER 4 DESCRIPTION OF LANDFILL FACILITIES

The purpose of this chapter is to acquaint the Operator with the facilities available at the site. A description of the facilities and their function are explained hereafter. The As-Built Drawings should be referred to for further understanding.

A. FACILITIES PROVIDED IN THE PILOT PROJECT

4.1 Weighbridge

Function: The weighbridge shall be used to weigh the incoming waste hauling trucks, in order to maintain a record of the incoming waste amounts at the Sisdol LF.

Description: The weighbridge is located at the entrance of the Sisdol LF. It has the following specifications:

- Platform type, installed over RC foundations and with an exit ramp. Approach is flush with the road.
- Material type is steel
- Platform size is 3 m x 9 m
- Weighing capacity is 40t maximum at 5 kg readability
- Four load cells are provided, each 20 t
- Two serial interfaces are provided, 1 RS232 for PC and a second RS232 for the indicator, with 7 segment display

4.2 Site Internal Road

Function: The internal road shall be used by the waste hauling vehicles to access the waste disposal areas in Valley 1.

Description:

- The road has a length of 190 meters and a width of 5 meters.
- Road is formed of two compacted earth layers; a 15cm thick sub-base coarse of sand mixed with gravel overlaid by a 10cm thick base course of broken stones
- Drainage ditch is provided on one side of the road
- Average gradient of the road is 1:10 and the road descends to about 20 meters over 190 meters length
- As the waste disposal activities progress it is necessary to construct new site internal roads that allow the waste transport vehicles to unload the waste directly at the disposal face

4.3 Basement Structure

Function: The landfill basement is composed of the layers that shall be overlaid by the leachate collection facilities and the disposed waste. The basement shall function to support the leachate collection pipes, waste haulage trucks, heavy equipment operation, and containment of the leachate within the landfill site.

Description:

- After completion of excavation works to the required levels the existing soil (basically blackish clayey silt mixed with overlaying gravelly sandy soil) was compacted to a rate of 82% to 96% (Dpr)
- Above the compacted existing soil layer two layers of clay were placed and compacted in 0.25 m layers to a total thickness of 0.5 m (laboratory tests confirmed a permeability coefficient of $k = 9.163 \times 10^{-8}$ cm/sec)
- A jute mat was laid over the clay liner in order to protect the liner
- Underneath the main collection pipes an HDPE sheet (350 micron) has been laid to offer more protection against seepage of the leachate collected to the pipe to the underground
- Above the jute mat a 30 cm thick drainage carpet (composed of river bed shingle/ pebbles of sizes 30-50 mm) has been laid to facilitate the percolation of the generated leachate towards the leachate collection system

4.4 Leachate Collection System

Function: The leachate collection system shall have two basic functions; to convey the leachate generated during the waste disposal activities to the leachate pond and to allow the air to flow into the disposed waste layers.

Description:

- A main leachate collection pipe line has been constructed and laid in a north-south direction with a total length of 115 m at a gradient of 3%
- The main line is constructed of perforated 600 mm diameter NP3 hume pipe (RC) pre-fabricated and brought to the site (holes of diameter 25mm and intervals 25 cm are provided
- Branch leachate collection pipes made of perforated 250 mm diameter HDPE were laid at a total length of 240 m (in the configuration as shown in the As-build drawings) at gradients of 4%
- The main and branch pipe lines were surrounded by filter materials of river bed shingles/ pebbles (50-150 mm) with the dimensions as shown in the drawings
- Seven (7) manholes were constructed (6 at connections between main and branch pipes, and 1 to connect two branch lines)
- The outlet pipe of the main pipe line is non-perforated RC pipe of 600 mm diameter and is designed that the invert level is 1.25 meters above the design HWL of the pond, the level at which the pond outlet pipe is located

4.5 Leachate Pond

Function: The leachate conveyed through the leachate collection system shall be stored in the leachate pond. An aerator has been installed in the pond to provide biological treatment of the leachate under aerobic conditions. A pump has been installed to re-circulate the leachate to the waste disposal area. The reasons behind this are to further treat the leachate under anaerobic conditions (within the waste) and also to speed up the decomposition of the disposed waste.

Description:

- The main leachate pond has a capacity of 500 m^3 (to accommodate estimated maximum leachate quantity for a period of 7 days) under the pond outlet pipe level (the outlet pipe connects the pond to the adjacent manhole)
- The pond dimensions are 10 m width x 20 m length at the bottom with sides sloping 1:1 and the design water depth is 1.25 m.
- The height of the pond has been increased by 0.7 m above the outlet pipe level by a perimeter masonry wall. This additional height provides an increased capacity for the pond.
- The pond bed is constructed of a bottom layer of 150 mm thick stone soling overlaid with a layer of 150 mm thick cement concrete with nominal reinforcement
- The walls of the pond are made of 150 mm thick cement concrete with nominal reinforcement
- A RC outlet pipe at a height of 1.25 from the pond bed allows the leachate to flow out into an adjacent manhole if the valve is opened
- The adjacent manhole is 1.9 x 1.65 m clear dimensions and depth of 1.83 m, with walls of stone masonry and a floor of stone masonry and PCC, over a boulder layer.
- A 250 mm diameter inlet valve is installed within the manhole
- The manhole has an outlet Hume pipe of diameter 250 mm which leads to an outfall structure made of stone soling
- Two additional ponds have been constructed downstream the main pond, the first directly adjacent to the main pond and south of it, and the second about 100 meters downstream in the west direction. The combined storage capacity of these two additional ponds is around 250 m^3.
- The Operator has a plan to construct two charcoal tanks downstream of the additional ponds to further treat the leachate in case of need to discharge into the river.

4.6 Aerator

Function: The aerator has the function to introduce air or oxygen into the leachate. This will provide aerobic conditions for the leachate and assist in biological treatment.

Description:

- Floating Surface Aerator (electrically powered) has been installed
- Capable to transfer atmospheric oxygen at a minimum rate of 1.6 kg O_2 per brake horsepower per hour (HP/HR)
- Vertical electric motor 10 HP (7.5 kW) suitable for continuous operation at 1800 RPM 220 volts, 3 phase, 50 cycle, TEFC, minimum Class F insulation system
- Three numbers FRP lined floats with necessary hooks and nylon ropes, with a minimum excess floatation of 130 kg
- Stainless steel anchor cables has been installed so that the aerator may rise and fall with the water level variations, but have other motions minimized

4.7 Re-circulation System

Function: The leachate re-circulation system will function to pump the leachate stored in the pond back into the disposed waste area. The reason for this is to prevent overflow of the pond, especially during the rainy season and also subject the leachate to anaerobic conditions

to effect the nitrification and de-nitrification process. Re-circulation of the leachate to the disposed waste will also speed up the de-composition process of the waste and hasten its stability especially during the dry season.

Description:

- Six (6) sprinklers are temporarily fixed on to the vertical gas vents and connected to the pump by a hose pipe (80 mm diameter)
- Sprinklers may be detached and fixed to other vertical gas vents and their height should be increased as the waste height increases
- A pump of capacity 7.5 kW is installed in the pump house adjacent to the leachate pond and used for pumping leachate out of the pond and into the hose for conveyance to the sprinklers
- A vertical steel pipe is installed to connect the pump to the waste disposal area
- A second submersible pump has been provided by the Operator to boost the re-circulation system

4.8 Landfill Gas Vents

Function: The installed vertical gas vents shall function to remove the landfill gas generated during the waste decomposition from the disposed waste to the atmosphere (passive gas venting). The vents shall also function to introduce air into the disposed waste to support the semi-aerobic system. It will be necessary to increase the heights of the gas vents as the waste disposal progresses and the disposed waste heights increases.

Description:

- At 20 locations intersecting the leachate collection pipes, perforated PVC gas vents (diameter 160 mm) have been vertically installed
- Vertical gas vents intersecting main leachate pipe mounted within stone boulders surrounded by gabion
- Vertical gas vents intersecting branch pipes mounted within oil drums and surrounded by gravel

4.9 Pump Control Room

Function: This room is constructed adjacent to the leachate pond and the re-circulation pump and electric panel to operate the aerator are stored there.

Description:

- Room of dimensions 4 m by 3 m constructed on stone soling foundation
- Walls made of stone masonry and SWG CGI sheet roofing
- Door and window provided

B. FACILITIES DEVELOPED SEPARATELY BY SWMRMC

4.10 Waste Bordering Dam

Function: The waste dam is located downstream of Valley 1 near to the Kolpu River. The dam functions to retain the waste within the disposal site and to separate the landfill area from the leachate pond and the river.

Description:

- The dam dimensions are 36.5 m long, 1.2 m crown width and has a height of 4.9 m above the landfill ground level, with a total height of 7.3 m
- Dam is constructed of stone masonry
- Outside slope of the dam is 2:1 while waste side dam slope is vertical
- During construction works of Valley 1, the central section of the waste dam collapsed and visual inspection indicated that insufficient cement mortar may have been the cause. The Operator should monitor the dam stability at all times.

4.11 Surface Water Cut-off Drain

Function: The main function of this cut-off drain is to prevent the water from entering into the site from elevated areas above the site. Water is collected into the drain and conveyed to a manhole downstream the site by gravity. It then travels through an RC pipe to an outfall structure and into the river at a point downstream the site.

Description:

- Constructed of stone masonry with a plain concrete bed
- Total length of the drain is 245m
- Drain hydraulic radius is 0.11m

4.12 Fencing

Function: The site is surrounded by a fence to maintain access control. The fence will also function to retain plastics and papers blown by the wind from leaving the site.

Description:

- Two types of fences shall be installed; one is barbed wire fencing with wooden poles and 180 m long
- Second type is GI mesh wire fencing with concrete poles, 2,600 m in length

4.13 Water Supply

Function: Water supply is required at the site for the staff. Water is also needed for land filling purposes, such as extinguishing fires, washing equipment or watering dirt roads.

Description:

- For the present water shall be supplied by tapping the spring water located near the upper terrace area north of the landfill
- A constructed intake collects the water which is then drained through an underground pipe and conveyed through an overhead 32mm diameter polythene pipe
- This supply may not be sufficient and SWMRMC is considering to develop a system to take water from the nearby Kolpu river

4.14 Gates

Function: The gates, along with the fence will control site access. The gates have not yet been installed but have the design features as described below.

Description:

- The main entrance gate is located east of the site at the administration area
- The entrance gate, for vehicles has a width of 5 m and shall be installed between two RCC pillars
- A separate small gate shall be provided for pedestrians

4.15 Electricity Power Supply

Function: The electricity power is required for operation of the weighbridge, aerator and re-circulation pump. Power is also required for the administration area.

Description:

- A three phase electric power supply shall be extended to the site from Kakani, Nuwakot district
- The line shall be overhead at the site and extended to the leachate pond area to power the aerator and re-circulation pump

4.16 Equipment/ Vehicles Shed

Function: The shed shall be used for small repairs, washing and parking for three heavy equipment units.

Description:

- Constructed of stone masonry with truss CGI roofing
- Three compartments of dimensions 7.0m x 3.75m with a total length of 21.75m

4.17 Administration Building

Function: The administration building provides office space for the landfill staff and weighbridge operator room.

Description:

- Constructed of stone masonry with CGI sheet roofing and dimensions of 8.9 x 8.5m
- There is a small veranda in the front

4.18 Toilet Block

Function: To be used by staff and visitors.

Description:

- Two cabins with flush type
- Dimensions of 3.7 x 2.25 m
- It flushes into two pits, the second to be used after the filling of the first
- Water is supplied by an HDPE water tank of 1,500 liter capacity

CHAPTER 5 OPERATION CONDITIONS

The operation conditions that should be understood by the beneficiaries of the site are described in this chapter.

The Operator may change these conditions in order to improve the operation or meet unforeseen circumstances. In such case the modified information should be made available to the landfill beneficiaries.

5.1 Operation Hours

The Sisdol landfill shall be operated daily.

1) Daily Operation hours: 06:30 to 15:00
2) Saturdays and National holidays: 06:30 to 13:00
3) These hours will apply to all seasons

5.2 Permissible Waste

The Sisdol landfill shall accept all non-hazardous municipal solid waste types, including domestic, industrial, commercial, market and public cleansing from the KMC, LSMC, KRM and Nuwakot District. The estimated average daily amount of waste to be disposed of at the site is 350 tons.

Hazardous waste, infectious waste, radioactive waste, liquid waste and other waste not considered as municipal waste shall not be accepted at the Sisdol landfill.

5.3 Non-permitted Practices

The following activities and practices shall be prohibited at the Sisdol landfill.

1) Waste picking and scavenging activities
2) Open burning of the waste
3) Utilization of heavy equipment provided for the landfill operations for other purposes (the Operator may dispatch heavy equipment to support simple repairs that may be required in the access road)
4) Allowance of non-authorized personnel access to the landfill

CHAPTER 6 PHASING PLAN

6.1 Overall Site Development Plan

The Sisdol landfill will be developed in three (3) phases. The total landfill life will be approximately 3 years.

The site is composed of two valleys; Valley 1, the west valley slopes downstream in a north-south direction, and Valley 2, the east valley slopes downstream in a northeast to southwest direct. Assuming a maximum fill height of 27 meters for Valley 1 and 23 meters for Valley 2, the landfill capacity of each is estimated to be 166 thousand m^3 and 109 thousand m^3 respectively.

Two alternatives have been proposed for the development of the Sisdol landfill[3] as described in Table 6.1.

Table 6.1 Development Alternatives

	Alterative 1	Alternative 2
A DEVELOPMENT PHASING		
Phase 1	Valley 1 – Max. disposal height 11m	Valley 1 – Max. disposal height 27m
Phase 2	Valley 2 – Max. disposal height 7m	Valley 2 – Max. disposal height 23m
Phase 3	Valleys 1 and 2 – Max. disposal height 16m	
B COMPARISON OF ALTERNATIVES		
	1. Better slopes stability 2. Gentler slopes for internal service roads 3. Phase 1 will have a capacity of 4-5 months during which Valley 2 has to be developed 4. More leachate will be generated	1. Phase 1 will have a capacity of 12 months thus providing more time for development of Valley 2 2. More rapid stabilization of the waste in Valley 1 3. Lesser leachate generated as final capping is provided for Valley 1 before proceeding to Valley 2

In March 2007, Valley 2 became ready for operation and waste disposal in Valley 1 was up to the mid point. Due to the following reasons the Operator decided to select Alternative 1;

- It will be easier to operate Valley 2 during the wet season which is after two months, provided the all weather access is secured for the waste transporting trucks to the disposal face.
- It is better to minimize leachate generation in Valley 1 because of the comparatively smaller storage capacity there and therefore waste disposal operation there should be suspended during the wet season.

The following works need to be implemented by the Operator in the next couple of months prior to the rainy season.

- In order to minimize the leachate generation in Valley 1, the waste leveling works will be completed, an intermediate cover will be applied and the surface drainage system will be constructed.
- To prepare Valley 2 for the wet season, it is necessary to develop the internal road system, using properly laid waste and covered with gravel.

[3] Refer to the detailed design report for the pilot project, JICA Study Team, September 2004

6.2 Development within Phase 1

The waste will be disposed in Valley 1 during Phase 1, for about 12 months. The waste disposal will start from the north-east corner of the site, adjacent to the internal service road and proceed downstream towards the waste dam.

At the commencement of operation and for the first 3-4 months about 40-60 tons of waste will be disposed of at the site daily. The first waste disposal layer will be around 1.5 to 2.0 meters in height in order to protect the laid facilities from damage by the heavy equipments operation. Consecutive waste layers shall be about 0.5 m depth within cells of 10 m x 10 m, assuming a compacted waste density of 0.6 t/m^3. Once a waste platform is prepared, with the compacted waste covering the entire Valley 1 bed, the compaction density shall be increased to around 0.8 t/m^3.

Once the arriving waste reaches the expected full capacity of 350 ton/day it will be necessary to operate two cells, with each cell dimensions being 20 m x 20 m, and with the same depth of 0.5 m.

6.3 Development of Phase 2 (Valley 2)

Development of Valley 2 has been made under the same principle of the semi-aerobic system. The existing ground level has been deepened through excavation, a waste dam constructed downstream Valley 2, soil investigation was implemented and clay liner has been laid.

A leachate collection system has been introduced and a sedimentation pond, leachate collection pond and charcoal filter ponds have been constructed downstream the dam.

Completion of implementation of Phase 2 development should proceed in a timely manner in order that there will be no disruption of the waste disposal activities once Phase 1 is completed.

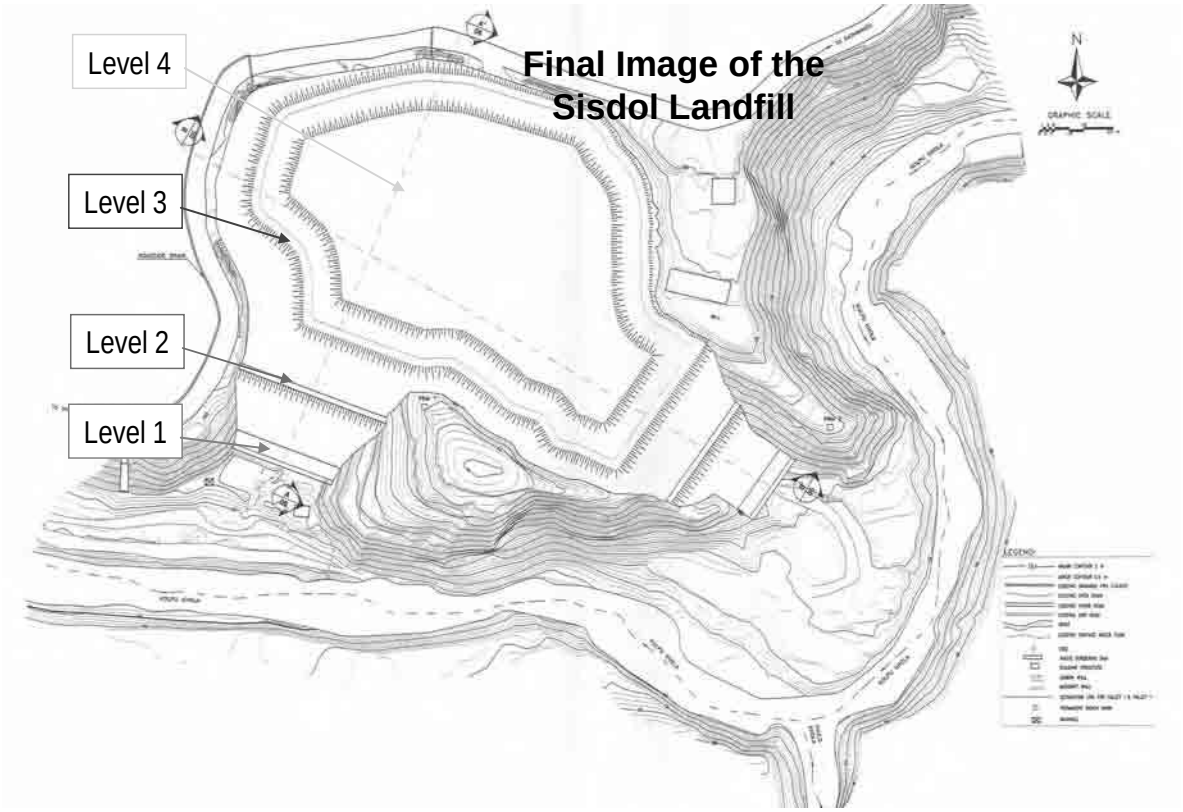
6.4 Development of Phase 3 (Valley 1 and Valley 2)

The landfill shall be developed in four levels (as shown in the following figure). Phase 3 will cover the development of the fourth and final level.

Before commencement of Phase 3, these works should be completed:

- Application of final soil cover and storm water drainage system should be installed in all the completed three faces in Valleys 2.
- Soil cover applied to completed faces of Valley 1 at the end of Phase I should be re-checked and repaired as necessary.
- Turfing along the completed slopes in order to stabilize the waste slopes.

The detailed design has provided the completed landfill plan and longitudinal sections. However the storm water drainage system needs to be designed based on the existing conditions. Some survey works will be required for this purpose.



(Note: Slopes in the drawing have been drawn as 1:2. It has since been recommended to adopt slopes of 1:3. Furthermore the landfill site conditions have changed with the excavation of some areas during operation. Accordingly the final plan will be changed.)

CHAPTER 7 LANDFILL OPERATIONS

7.1 Waste Stream Accounting – Weighbridge Operation

The weighbridge operation shall have two main functions:

- It is the first point of entry to the landfill where the waste transporting vehicle may be inspected to assess the suitability of its load for acceptance at the site, and
- It shall provide the data for recording the arriving waste particulars (Form 1 – Weighbridge Record)

(1) Waste Inspection

a. Each arriving vehicle should show the permit it has from the served municipalities (KMC, LSMC, KRM) to collect and transport *municipal* solid waste (without such permit the vehicle load shall be rejected)

b. The weighbridge operator may demand a visual inspection at which time the vehicle will be directed to a separate location for inspection (subject to vehicle type inspection may be made by looking into the vehicle from the top or dropping some waste at a designated point)

c. Regardless of initial waste acceptance at the weighbridge, at the time of waste un-loading at the active waste cell the waste may be rejected should the load be found to contain un-acceptable materials (the ejected waste would then be re-loaded into the vehicle and sent away from the landfill)

d. Based on the above inspection, should a vehicle not be permitted to discharge its load at the landfill then the vehicle number, driver name, date and time of arrivals, and reasons for rejection shall be reported to the respective municipality and the vehicle in question shall not be allowed at the site in the future until the involved municipality submits an explanatory report to the landfill management on the incident.

(2) Weighbridge Record Information

a. A form shall be prepared for the purpose of storing the recorded information

b. A coding system shall be prepared for inputting the collected information into the computer

c. The final form shall be distributed to the concerned municipalities in ensure that the required information may be obtained

d. The data to be recorded shall be:

(1)	Vehicle number	Weighbridge operator
(2)	Driver name	Driver
(3)	Arrival time	Weighbridge operator
(4)	Vehicle weight (with waste load)	Weighbridge operator (each vehicle shall be weighed once when empty to calculate the waste weight)
(5)	Trip origin	Driver (for transfer haul specify transfer station name, for direct haul specify collection zone)
(6)	Departure time	Weighbridge operator

e. The recorded data shall be input into the computer on a daily basis using the coding format.

7.2 Waste Un-loading

Landfill staff will direct the vehicle driver to the active waste disposal areas. Operators at the active fill areas will direct the vehicle to the appropriate disposal area along the working face as required. No vehicles will be permitted to un-load their waste at any location other than the area designated by the landfill staff.

The Operator will make utmost efforts to ensure that the waste vehicle may access the working face as close as possible, through preparation of the internal site roads.

The Operator will maintain control of the waste unloading within the active disposal area in order to minimize the width of the working face, and decrease the unloading and waiting times. The driver may be instructed to un-load the waste in two or three different places.

7.3 Cell Configuration

A cell shall be prepared to accommodate one day's waste. The cell area should not be too large to limit the leachate production. The cell shall have a height of 1-2 m and the waste deposited in layers of around 30-50cm to allow for more uniform compaction. The width shall be sufficient to allow for 2-3 vehicles to discharge the waste at the same time (i.e. minimum 10 m).

The borders of the cell shall be delineated by soil bunds which shall be used for the cover material source at the end of the working day.

The waste shall not be pushed over a vertical face. It shall be deposited at the top or base of a shallow sloping working face. The bull dozer shall be used to push the waste up or down the slope.

Example for Cell Size Calculation:

(1) First Waste Layer
- It is expected that at the commencement of operation, approximately 40 t/d of waste shall arrive to the landfill.
- The thickness of the first layer of waste shall not be less than 2 m in order to avoid damage to the basement by the heavy equipment. The estimated waste placement density is 0.5 t/m^3.
- At subsequent layers the waste depth shall be roughly 0.8 m (to allow for waste placement in 2 layers of 0.4 m each).
- Accordingly the cell area = (40 t/d)/(0.5 t/m^3 x 0.8 m) = 100 m^2.
- With each side roughly 10 m x 10 m.

(2) Cell Size at full operation level
- At full operation the waste amount hauled to the site shall be around 350 t/d.
- The waste shall be compacted and compacted density shall be around 0.8 t/m^3.
- The waste depth shall be kept at a minimum 1.5 m.
- Accordingly the cell area in this case shall be around 300 m^2, with dimensions of 15 m x 20 m.

The Operator needs to keep at the site leveling apparatus, measurement tape, string and marking chalk or pens to designate the cell dimensions for the heavy equipment operators. Cell design heights may be marked on the vertical gas vents. String may be strung to mark the cell confirguration.

7.4 Spreading and Compacting

In order to protect the basement structure special care will be exercised in the placement of the first waste layer. The waste in that layer will be deposited to a height of about 2 meters. This first layer shall be compacted using bull dozer in order to avoid over compaction. No compactor shall be used on the first waste layer which shall be spread with sufficient size to form a waste platform on which the waste carrying vehicles may access the working faces, unload the waste and turn to leave the working face area.

For the following layers, uniform compaction levels will be promoted throughout the site by limiting the thickness of each waste layer and using sheep-foot compactor. The landfill staff shall control the spreading of the waste materials along the working faces so that a compacted layer thickness of approximately 0.3 meters will be achieved. This should result in uniformly well-compacted waste layers with little potential for excessive or uneven subsidence.

Should the waste contain large or bulky materials which may not be crushed by the compactor, these materials should be removed, crushed and then returned to the waste fill area.

The most effective compaction occurs when the compactors are operating on levelly spread waste. However the actual waste un-loading and pushing the waste will tend to create sloped waste layers. Therefore these slopes should be mild not in excess of 3 horizontal to 1 vertical.

The number of passes of the compactor is important in order to achieve high densities. Normally 3 to 5 passes should be made for each layer. Passes more than 6 or 7 will not produce significant compaction for the effort expended. As a rule, the passes of the compactor should not be less than 2 passes. The number of passes may be slightly increased in case of spreading and compaction by bull-dozer.

In the absence of the compactor, the Operator shall make best efforts to achieve the required compaction using the bulldozer. The waste carrying vehicles passing over the waste will also aid the compaction efforts.

7.5 Cover Material Source and Placement

Application of the cover material is one of the most important countermeasures to mitigate a number of environmental concerns.

At the end of each working day a 15 cm thick layer of soil cover will be placed and compacted over all the waste material disposed at the landfill on that working day.

Intermediate cover will be placed over disposed waste in areas where further waste placement will not occur for at least 6 months. The intermediate cover will be placed on the third face of Phase I (Valley 1) as the disposal activities shift to Phase II (Valley 2). The intermediate cover will be spread and compacted to a thickness of at least 30 cm. The intermediate cover will be graded to allow for surface water run-off and reduce ponding and infiltration.

The final cover will be placed once waste disposal operation is completed. The final cover will be at least 0.5 to 1.0 meter compacted thickness and will include layers of soil to reduce infiltration, prevent erosion and support vegetation. The final landfill cover will be

re-seeded with native vegetation to minimize the visual impact of the final landfill surface and to provide a natural habitat consistent with the surrounding environment.

Prior to application of the final cover the Operator shall prepare that layer and submit it to the concerned authorities (KMC, LSMC, SWMRMC and Okharpauwa Sanitary Landfill Site Main Coordination Committee (OSLSMCC)) for their approval.

The cover material shall be obtained from the site. Materials excavated during the pilot project construction are stockpiled and these shall be used. In principle care shall be taken to apply materials that will not hamper the passage of heavy equipment on the successive waste layers.

The cover materials shall be brought to the active disposal areas using a wheel loader. Compaction of the cover layer shall be made by the bull dozer of compactor. Compaction shall be of sufficient degree so as not to hamper successive disposal works.

7.6 Stockpile Requirements

The Operator shall at the start of operations identify the stockpiles locations and volume of materials available and already prepared during the pilot project construction, from the excavation works.

During the course of the disposal operations and as the stockpiles become depleted, the Operator shall replenish them from materials excavated from Valley 2. In the case where there is a shortage of materials for the cover at the site, it is recommended to excavate materials from the nearby Aletar site.

Further as the disposal work progresses the Operator may decide to place stockpiles in new locations to ease the materials transport to the active waste area.

Under no circumstances will the Operator endanger the cover materials stockpiles either by neglecting to replenish the materials or locating the stockpiles at in-accessible locations.

7.7 Permanent Drains Maintenance

The landfill is served by a perimeter cut-off drain along the northern border. A second storm water drain is located at the side of the internal service road. Both drains should be regularly cleared from fill or debris in order to function efficiently.

With the completion of the Phase I works permanent drains will be constructed along the first and second levels in Valley 1. These should also be maintained by the Operator.

7.8 Temporary Drains

Temporary drains, in combination with earth bunds, may be constructed during the operation to divert storm water from entering into an active waste disposal area. The Operator shall ensure that these drains do not convey the water outside the site. The water collected in these drains should ultimately seep into the disposed waste and enter into the leachate collection system to be conveyed to the leachate pond.

Once these drains have served their purpose they should be reclaimed properly. No standing water should be allowed in any part of the landfill.

7.9 Leachate Pond Aeration

Aerator operation is important to provide biological treatment for the generated leachate and also as a countermeasure against odor emission from the leachate stored in the pond.

During the rainy season and when the pond is full the aerator will in principle be operated on a daily basis, for about 6-8 hours a day. Should there be any electricity power failures; the aerator shall be given priority for connection to the generator.

The Operation Manual provided by the aerator manufacturer will be referred to for operation and maintenance issues.

Should the odor generated from the leachate pond become very serious, additives to depress the odor may be added. However such additives should not be of toxic or hazardous nature.

7.10 Leachate Re-circulation

Leachate re-circulation shall be performed to allow for an increased rate of waste decomposition and provide further treatment to the leachate through exposure to anaerobic conditions.

During the dry seasons the leachate re-circulation shall be done on a regular basis so as to mitigate the build-up of leachate at height of over 30 cm above the basement and subject the disposed of waste to moisture in order to hasten the decomposition process. However during the rainy season the re-circulation shall be done on as required to prevent against overflow of the leachate pond.

Any sludge accumulated at the bottom of the pond shall be removed and deposited over the waste.

Subject to the monitoring results of the leachate and the leachate quality the Operator may need to construct trickling filters within the waste disposal areas and re-circulate the leachate through these filters to improve its quality. The filter may be formed by excavating a pit of about 1.0 m depth and 5 m by 3 m. Gravel should be placed in the pit with vertical perforated pipes.

7.11 Horizontal Leachate Trenches at Intermediate Levels

Horizontal intermediate leachate trenches shall be constructed to strengthen the semi-aerobic function through collection of the leachate and passage of the air.

Maximum waste design height is around 20m. At an intermediate level of 10 m height, the Operator shall construct leachate trenches; using gravel of size 30 to 50 mm (either crushed gravel or river-bed gravel may be used). The trenches shall follow the similar configuration to the main leachate pipe collection system.

7.12 Gas Vents Extensions

As the waste height increases it will be necessary to increase the height of the gas vents. This will be necessary in order that the gas vents continue to passively expel the generated landfill gas and introduce air into the disposed waste layers. The Operator shall use PVC vents and shall surround them with aggregate to protect them, with a diameter of minimum 1.5m. The development works shall be done considering maintaining the vents free of any foreign materials.

7.13 Operation in Rainy Season

There should be no interruption of the disposal operations during the rainy season.

The three major factors of concern during this season are the increased generation of leachate, the difficulty of accessing the internal service road and finally the application of cover materials.

Concerning the increased leachate amount, as discussed in previous sections the re-circulation system shall be used to avoid over flow of the collected leachate in the pond to the adjacent river.

Concerning the internal service road, the Operator shall in advance of the rainy season strengthen the road by applying a lime-stabilized sub-grade or other suitable materials (such as cement-stabilized gravel).

The cover soil used during wet weather operation must be granular to allow for ease of placement and compaction. Silt and clay materials will be unworkable when exposed to excessive moisture. The Operator should stockpile such materials well in advance of the rainy season.

The Operator should avoid access of heavy collection trucks directly over the waste areas during the rainy season and instead rely on lighter weight heavy equipment (as bull dozer and wheel loader to transport the waste to the active cell area).

7.14 Special Waste Handling

Sisdol LF is not designed to handle special waste (e.g. liquid waste, chemical waste, hazardous waste, etc.). Should such waste be delivered to the site, the truck hauling these waste shall be refused access, in case of detection at the entrance of the site, or be requested to re-load and remove the waste, should the nature of the waste be detected during the unloading operation.

7.15 Basic Landfill Equipment

Sisdol LF shall commence operation with around 40 t/d of waste arrivals for the first three to four months. During this period the first waste layer shall be constructed. Excessive compaction will be avoided in order to protect the leachate collection system and basement liners.

Accordingly at this initial stage wheel loader, excavator and bulldozer will be required. Wheel loader will mainly transfer the un-loaded waste from a designated tipping point to the

active cell, excavator will be used to move the cover materials and bull-dozer will be used to spread the waste and provide some compaction.

Once the landfill reaches its maximum waste arrival acceptance amounts (around 350 t/d) it is recommended to supply a sheep-foot compactor.

7.16 Landfill Equipment Maintenance

In principle simple repairs and daily inspection for the heavy equipment shall be carried out at the site. For this purpose the Operator shall include a mechanic within his site team. The site shall also have some spare parts, and required equipment for the maintenance.

For larger maintenance work the equipment will be transported to a qualified workshop.

Each unit of equipment will have a maintenance record identifying the dates of inspections, repairs, and maintenance. The contents of each inputted data will be described in detail.

For light equipment, such as aerator, pump and generator there shall be daily maintenance checks for oil and lubricants. The Operator stationed at the site should also be capable to provide simple repairs for the equipment.

7.17 Intermediate and Final Closure Works

Closure works will be implemented gradually as sections of the landfill site reach the waste disposal completion design levels. Such sections shall include when the waste reaches the final waste dam height and the road height.

At these levels (waste dam height and road levels) the waste will be filled to a horizontal level and inwards for a minimum width of 5 m before starting to build the following lift. No further waste disposal activity will be permitted at these sections (Schematic drawings are shown in Figure 7.1).

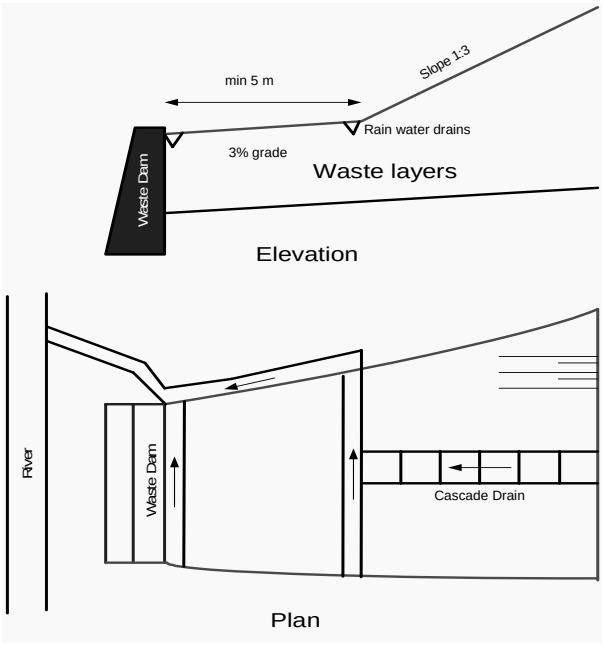


Figure 7.1 Schematic Early Closure of Certain Landfill Sections

The waste slope at the following slope shall be maintained at 1:3 to avoid waste collapse.

The final layer of waste (both horizontal and inclined) shall be topped with a capping soil of thickness around 50 to 100 cm. This capping soil shall be of material supportive to vegetation.

A drainage system shall be designed at the capping soil layer. The drainage system shall have the function to decrease the amount of rain water infiltrating into the waste by collecting and draining the rainwater. The drainage system shall consider appropriate gradients, horizontal and inclined drains, and flow of the collected rain water from the drains (possibly to the outfall structure located west of the site) or to the manhole located adjacent to the leachate pond.

Settlement is expected to occur at the final cover after a period of time and the Operator should monitor the areas where final cover has been applied, re-fill the areas where settlement has occurred and re-compact.

CHAPTER 8 ENVIRONMENTAL CONTROLS

8.1 Leachate Re-circulation and Aeration

The leachate re-circulation system shall provide the following environmental controls:

- Decrease the amount of leachate stored in the pond in order to prevent the overflow of the leachate
- Spray the leachate into the active waste cell so as to provide leachate treatment through anaerobic conditions

The re-circulated leachate should not be allowed to form ponds in the waste disposal area. If there is difficulty in seepage of the re-circulated leachate to certain parts of the disposal site, other areas should be selected.

The leachate aeration in the leachate pond shall provide environmental control as enhancing decomposition of organic pollutants in retained leachate and decrement of odor emitted from the pond. The operation of aerator shall be in line with the description herein.

8.2 Sludge from Leachate Pond

Over a long period the sludge may pile up causing the leachate pond volume to decrease. Periodically an excavator should be employed to remove the sludge from the pond and dispose of it in the waste active area. For this purpose a suitable sized excavator should be made available. It is advisable to avoid manual removal of the sludge from the pond.

The road along the pond should be maintained for ease of access at any time by the excavator.

8.3 Dust

On-site dust will be controlled through the following measures:

- Use of water tank
- Cover material will be applied at the active waste disposal areas.
- Continued attention to be given to proper maintenance of internal service roads
- Planting and maintenance of vegetation on closed fill slopes
- Use of leachate re-circulation system in the active waste disposal area or over the daily cover only (sprinkling of leachate over areas closed by intermediate or final cover will be avoided)

8.4 Litter

The Operator will attempt to minimize windblown or dropped materials on site. Portable litter fencing will be installed at active fill areas to catch windblown materials, as required. Both the portable and permanent fencing will be inspected and cleaned daily.

Waste paper materials may require the addition of water to eliminate scattering. The landfill will be inspected daily for waste materials that may have been blown or fallen from trucks. Ditches will be kept clear of litter material.

Haulers will be instructed to cover loads. Access road leading to the site will be inspected regularly for waste materials. The right-of-way of the road will also be inspected, along both sides at least once every week.

8.5 Vectors

By definition, a vector is an insect or animal that can carry disease. Landfills are a potential breeding ground for vectors if control measures are not sufficiently exercised. These vectors commonly include flies, rats, mice and birds.

The first line of defense against vectors is the speedy, regular and proper application of cover materials.

Regular check and inspection to confirm that rats, mice and flies are not thriving in the landfill is necessary. Should there be concern; traps may be set to confirm the presence of rats and mice. Similarly for flies some counting method may be applied to identify the extent of the problem.

Should there be a serious problem then application of poison and insecticides should be considered. A special plan specifying type of insecticides or poison, waste amount, time of use, etc. should be developed by experts. It may be necessary to temporarily close the site to avoid any health danger to the site staff when these materials are used. Finally the effect these materials may have on the generated leachate should be considered.

The landfill will also attract dogs. More care to cover the waste on a daily basis and ensuring secure fencing system around the site should be done to decrease the number of dogs.

8.6 Bird Nuisances

A bird control plan shall be developed based on the site conditions. The cover material application is the primary control method. Other methods that may be considered include stretching of strings overhead the site to obstruct the birds' glide paths, and acoustical devices that emit noises that scare the birds away.

8.7 Noise

Heavy equipment and collection trucks should be in a good order to avoid excessive noise emission. A serious condition may require the construction of noise berms.

8.8 Erosion Control

In order to prevent slope damage as a result of erosion part of the runoff water on the side slopes of the landfill will be directed to the perimeter cut-off drain. This drain should be maintained in a clear condition.

Waste slopes in the disposal areas shall be formed of grades of minimum 1:3. Waste slopes shall be properly covered and served by open drains to collect and divert the storm water. Such drains may need to be lined with rocks. Vegetation shall be planted along the slopes as possible to reduce erosion. Plants should be resistant to waste.

8.9 Odor

The daily soil cover application is the primary control method. Should there be a serious problem on odor then applications of spraying with aroma-masking agents or chemicals should be considered. These agents/chemicals shall be non/less harmful to the site staff, surrounding communities and environment when applied. Attention shall be paid on the possible increment of leachate generation volume from the landfilling area due to the excessive spraying. Odor in post-closure phase will be controlled by the placement of a final capping cover.

8.10 Buffer Zone

Buffer zone will be functioning for avoidance of the undesirable access to the site by the outside people as well as for mitigation of environmental nuisance by site operation such as odor. Tree planting and fencing around the perimeter of the buffer zone should be made as required.

CHAPTER 9 ENVIRONMENTAL MONITORING

9.1 Water Quality Monitoring

9.1.1 Monitoring Location

Water quality monitoring shall be made at the following locations:

- Groundwater: Monitoring wells of Borehole (BH)-1 and BH-2. (*Groundwater of BH-3 should be also monitored as long as the hole is not covered by the waste disposal)
- Leachate: Leachate outlet pipe and retention pond.
- Surface water: Upstream of Kolpu Khola (1 location), Downstream of Kolpu Khola (2 locations), Thulo Khola (1 location).

9.1.2 Monitoring Parameters and Frequency

The parameters to be monitored are recommended as follows based on the effluent standards of MOEST and the EIA Guidelines by SWMRMC.

A. Field measurement (Twice a year)
Weather, Air temperature, Water temperature, Color, Transparency, Odor, Appearance, River flow*1, Discharge*2, Groundwater level*3, pH, DO, EC
B. Indicators (Twice a year)
TDS, TSS, HCO3-, BOD, COD, Potassium permanganate consumed, Cl-, Ca++, Na+, SO4-, SO3-, S, NH4-N, NO3-N, NO2-N, T-N, PO4-P, Oil and grease, Coliform
C. Metals and others (Annual)
Phenol, F, As, Cd, Cr (total), Cr (hexavalent), Cu, Pb, Hg, Ni, Se, Zn, Fe, Mg

*1: Only for surface water
*2: Only for leachate outlet pipe
*3: Only for groundwater

9.1.3 Sampling and Analysis

Sampling and field measurement shall be carried out by a qualified water quality expert under the supervision of the LF operator. The testing/analysis of samples shall be carried out at a certified laboratory.

Especially regarding the monitoring of the leachate, a timing and location of the sampling and field measurement works shall be regularized as follows in order to have an effective accumulation of monitoring results.

- Sampling/measurement shall be made after operating daily aeration.
- Location of sampling/measurement in the leachate retention pond shall be fixed.

9.1.4 Relevant Data/Information

The following data/information shall be obtained and recorded by the qualified water quality expert simultaneously with the sampling and field measurement works, in order to support the interpretation of the monitoring results.

- Rainfall intensity and weather condition during the three days before the date of sampling and field measurement.

- Track of the aerator operation i) on the date of sampling and field measurement, and ii) during the three days before the date of sampling and field measurement.
- Sampling point especially in the leachate retention pond.
- Track of the valve operation of leachate retention pond in an emergency case before the date of sampling and field measurement.
- Photos of each of the monitoring locations at the time of sampling and field measurement works.

9.1.5 Maintenance of Wells

The groundwater wells will be inspected on a regular basis (minimum every 3 months) for signs of damage. Damaged wells will be repaired or replaced as necessary. Replacement wells will be constructed adjacent to the damaged well and with the same depth.

9.1.6 Ad Hoc Monitoring

- Precedent indicators monitoring will be carried out by the LF operator in ad hoc base in order to detect the precedent implication of probable water pollution by using portable equipment for on-site measurement. The precedent indicators will include pH, EC, and DO. Cl- is also preferable to be included in the indicators when the portable equipment has its function.
- The effect of the aerator on the leachate will be monitored to assess its performance. An indicator of adequate aeration is the presence of Dissolved Oxygen (DO) near the surface of the pond at a concentration greater than 6.0 mg/l. This should be checked at least once a week to ensure the pond has adequate aeration and to prevent emission of odor.

9.1.7 Monitoring Results Interpretation and Trouble Shooting

Should certain parameters show worse then the necessary actions should be planned and performed considering the following strategies:

- The analytical value sampled/measured at the downstream of Kolpu Khola can be said as a reference point by which implying whether an environmental damage on water quality would be acceptable or unacceptable. If unacceptable, the causality between the site operation and environmental damage should be examined by reading the accumulated monitoring results and site operation records. Supplementary sampling, measurement and analysis should be carried out as required for clarification of the bygone monitored data.
- Should the unacceptable environmental damage on water quality be identified as being caused by the site operation, then a cause should be clarified. One of the most probable causes would be related to the leachate retention pond, such as non-functioning of the valve, damage on watertight mortar lining on the bottom/sidewall of the pond, etc. Such trouble on the pond should be recovered when identified.
- Leachate percolation through the clay liner system in the landfill area would be also conceivable. If feasible and practical, such countermeasures are applicable as i) placing intermediate capping on the landfill area to avoid the accumulation of leachate percolation from the new waste, or ii) grouting or cutoff sheet pile works at the toe of the

waste dam. Temporary peripheral drainage around the landfilling area would be also effective to reduce the leachate generation.

The Environmental Coordination Committee shall be involved in the course of the above process for interpretation and trouble shooting.

9.2 Odor, Littering, and Settlement

The LF operator shall carry out the observation regarding the odor, littering of waste and settlement of landfill area in ad hoc basis. Should a serious problem be found then the countermeasures described herein should be considered and adopted. The observation results shall be recorded and accumulated in order to facilitate a future trouble shooting including the complaints from the local communities/people.

9.3 Landfill Gas Monitoring

Landfill gas vents will be monitored every three months using an appropriate gas analyzer unit. Records will be maintained regarding the time and date of monitoring and observed methane concentrations over the Lower Explosive Limit (LEL).

Periodic monitoring of the landfill gas shall be also performed at the administration buildings of the site in order to avoid the human health hazard on the site staff and workers.

9.4 Incoming Waste Monitoring

Incoming waste will be monitored for the presence of hazardous materials or liquid waste. Monitoring shall be by visual inspection. If it is realized that there is a serious problem in the detection of such waste than a more sophisticated monitoring plan may need to be developed.

9.5 Public Complaints Analysis

The landfill staff member responsible for public relations shall maintain a record of all complaints arriving to the site. The record should classify the complaints by type, number, frequency and the actions taken concerning each.

While the following complaint types are expected, there may be more.

- Water contamination
- Foul smell
- Waste scattering
- Odor
- Vectors
- Noise
- Health problems
- Birds
- etc.

CHAPTER 10 EMERGENCY MANAGEMENT

10.1 Types of Emergencies

Crises at the landfill that require the need for an emergency management and contingency plan include fires, release of methane or other noxious fumes, chemicals or fuel spills, earthquakes and heavy rains.

Other emergencies may include blockade of access road to the site by the surrounding residents, injuries or the operating staff, utilities failure or shortages, collapse of parts of the access road to the site, unauthorized scavenging and waste picking activities in and around the landfill, etc.

10.2 Emergency Management and Contingency Plan

The intent of this manual it to provide a guideline for operation and identify the potential emergencies. A separate Emergency Management and Contingency Plan (EMCP) needs to be prepared and distributed to the staff at the site in order to be aware and trained on the emergency response procedures.

10.3 Emergency Response

The response suitable to some emergency types is described hereafter.

(1) Unauthorized Load

Incoming load that could possible contain hazardous, toxic or infectious waste shall be inspected. Any load containing unauthorized waste will be rejected and proper reporting taken.

(2) Hazardous, Toxic, and Infectious Waste

In the event of any hazardous, toxic or infectious waste discovered at the active waste disposal area, site personnel will not attempt to cleanup such materials. A specialized company will be immediately contacted to identify and clean-up the spill.

In the meantime the following actions should be taken:

- Immediately cordon off area where suspected materials are found
- Relocate the working force as required
- If possible, identify the materials
- Contact a company specializing in hazardous and toxic materials to identify and assist to remove the suspected materials, as required
- Prepare full report with supporting documentation for submission to the relevant authorities

(3) Fire

Fires that may occur in the landfill waste will be controlled by the use of fire extinguishers, covering the burning materials with additional soil, or by spraying with water using the site

water truck. Once the fire is extinguished, the cell containing the burning materials will be excavated and the contents spread out in an isolated area of the site. Following confirmation that all burning materials have been extinguished, the waste will be covered with a minimum of 15 cm of soil.

The following actions will be taken if a fire occurs in the refuse fill area:

- Burning refuse will be buried immediately with cover soil
- The Fire Department will be summoned if site personnel and equipment cannot extinguish the fire. The contact information of the closest fire department should be available at the site.
- If the fire occurs at areas outside the active waste disposal areas, maximum effort shall be made to prevent the fire from spreading to the waste areas. One method may be to excavate a fire break between the active waste disposal areas and the oncoming fire.

(4) Earthquake

Should a strong earthquake occur, it is advisable to suspend the landfill operation in order to conduct a damage assessment of the site facilities. These facilities include, but are not limited to the waste dam, roads, administration buildings, gas vents, leachate pond, and utilities supply networks.

(5) Severe Wet Weather Conditions

In countries such as Nepal, where there is the Monsoon season, areas should be provided within the site for wet weather operations. These areas should have all-weather access roads and smaller active areas for the operation of heavy equipment. However, the Sisdol Landfill is very small and it is not possible to provide such an area. Under this condition actions as outlined in Chapter 7 should be considered.

If there is severe rainfall and fear of collapse of the landfill slopes or the disposed waste then it is necessary to suspend operation and take necessary actions such as application of cover materials and compaction of the effected areas, once the storm has abated.

(6) Waste Picking Activities

No waste picking activities will be allowed within the site or nearby.

Any illegal entrant to the site for waste picking activity or others shall be apprehended and as necessary handed over to the authorities.

The waste collection trucks shall be strongly monitored by the respective municipalities in order to prevent the drivers from cooperating with any un-authorized scavenging centers that may be established in the vicinity of the site.

(7) Access Road Problems

Should there be any disruption of transport to and from the site due to collapse of part or parts of the access road, the landfill operator should notify the Department of Roads for prompt action.

Depending on the extent of the road damage, the Operator may attempt to use the landfill heavy equipment to clear the damaged area. However even under such a condition, the operator should report to the Department of Roads later on the damage that occurred and the remedial works done.

Should the access road problem remain un-resolved then it would be necessary to suspend operation at the landfill (even though the collection trucks can access the site, other vehicles transporting workers or carrying site provisions may not be in a provision to access the site).

(8) Residents Site Blockade

All problems related to residents in the surrounding areas should be dealt with through discussions with OSLSMCC. The OSLSMCC representative should be informed immediately of the occurrence of such problems and take the necessary action to remedy them.

CHAPTER 11 LOCAL INTERACTION

11.1 Local Committee

Okharpauwa Sanitary Landfill Site Main Coordination Committee (OSLSMCC) has been established and legally registered to act on behalf of the surrounding residents in all actions pertaining to the sanitary landfill development and operation.

An agreement has been signed between the OSLSMCC, the SWMRMC as the site developer and the two municipalities of KMC and LSMC as the site beneficiaries. This agreement, in conjunction with a second agreement on the site operation signed between SWMRMC, KMC and LSMC, set out the obligations and rights accorded to all the signatories.

11.2 Environmental Coordination Committee

In line with the environmental monitoring requirements, and as described herein and in the agreements, an environmental coordination committee has been set up. The Operator shall assist this committee in its tasks.

11.3 Local Development Schemes

The OSLSMCC shall be responsible for formulating plans for local development which shall be discussed with the SWMRMC and the budget obtained as agreed upon.

The Operator shall be independent of these discussions and the Operator's sole concern shall be the technically sound and environmentally safe operation of the sanitary landfill. The Operator shall in no way neglect this main concern on the pretext of diverting manpower, equipment, or money from the operation of the site to such development schemes surrounding the site.

11.4 Site Public Visits

The Operator shall operate the site in a transparent manner and site visits by local resident groups, NGOs, academics and the media shall be sanctioned. However in order to protect the safety of the visitors, an official request for visits and permission given are required.

In principle the Operator should establish a schedule for holding monthly site visits and inform the OSLSMCC.

To make these recommended site visits more effective, SWMRMC and the Operator should prepare explanatory panels and brochures showing the design drawings, explaining the construction process and outlying the disposal work progress.

CHAPTER 12 POST CLOSURE PLAN

12.1 Introduction

Closure of the site will be accompanied by restoration to prepare the final landform through spreading of the soil and site maintenance during a post closure period.

The aftercare will include taking steps during and after restoration to bring the land up to the required standard for after use by cultivating, fertilizing, and draining the land to sustain vegetative growth.

The potential for environmental problems such as water supply contamination by leachate, waste washout due to flooding, slope failures and landslides, landfill gas migration, odor problems and uncontrolled fires can still exist after site closure. Thus in general, upon cessation of activities (i.e. waste acceptance) the necessary measures are to be taken to avoid any pollution risk and to return the site to a satisfactory state.

12.2 Capping of the Site

The capping system is the final component in the construction of the landform, and it comprises the engineering and restoration (or surface) layers. The restoration layer is to comprise of earthen material at least 1.0 meter thick which will support native plant growth and thus enable the planned after use to be achieved.

The engineered layers of the cap will comprise, as a minimum the following:

a) A protection layer – comprising of subsoil, to safeguard against intrusion by plants, animals, etc.
b) A barrier layer – may be compacted clay, geo-membranes or geo-synthetic clay to reduce infiltration of water into the waste and escape of gas from the waste
c) A gas collection layer – sand, geo-textiles or geo-nets to transmit gas to collection points.

12.3 Management of Leachate and Gas

The equipment used for leachate collection and gas venting and control is to be maintained in good condition in the post- closure period.

12.4 Settlement Monitoring and Maintenance of Final Soil Cover

During the aftercare period there are two aspects of settlement for the site operator to consider in relation to monitoring namely:

- Any further settlement of the waste due to consolidation
- Stability of other parts of the site, including slopes and associated structures

Investigation of the settlement potential and physical stability of the site is to be undertaken using theoretical and practical investigations, taking account of the composition and density of the waste deposited, an assessment of the magnitude of settlement and settlement trends, and identification and stability assessment of slopes and structures.

The soil cover which constitutes the final cap must remain stable and checks must be made to identify cracking of the capping layer. Regular maintenance is required to repair the effects of settlement, subsidence or erosion.

12.5 Surface and Groundwater Control

As outlined above, in order to ensure effective surface water and groundwater control and to maintain effective run-off and run-on, the integrity of the final cover must be maintained. The monitoring for ground water and surface water is to be continued during post closure.

Where pipes or drainage systems have been laid during the life of the site they are to be checked and repaired if necessary. In the event that modifications are necessary in order to maintain effective surface or ground water controls such changes are to be undertaken as soon as practicable.

12.6 Other Facilities

Roads and other site infrastructure are to be maintained in accordance with a post-closure plan. It will also be necessary to maintain site security and keep the site free from vectors.

Supporting Report L

Training for Operation and Maintenance of Sisdol Landfill

Supporting Report L

Training for Improvement of Operation of Sisdol S/T-LF

L-1 First Training for Improvement of Operation of Sisdol S/T-LF (September 2006)

1.1 Schedule of First Training

The first training in September 2006 was conducted as shown in the table below:

Month	Day	Activities	Remarks
September 2006	17	Meeting with SWMRMC, and Visiting facilities relating to SWM in KMC	Operation of the site was suspended
	18	Inspection of Sisdol S/T-LF	ditto
	19	Inspection of Sisdol S/T-LF, and Visiting proposed Banchare Danda landfill site	ditto
	20	Presentation of the results of inspection and recommendations for the improvement	ditto
	21	Report preparation	ditto

1.2 Activities at the Site

Since the operation of the site had been suspended, the following activities were conducted at the site as the inspection.

- Grasping landfill method and present condition of daily soil cover at the landfill site
- Grasping present condition of gas ventilation facility
- Measurement of concentration (%) of methane gas generated from the landfill site
- Discussion with operation staff

1.3 Results of Inspection

(1) Landfill method and gradient

- Cell method had been adopted for landfill operation
- Thickness of waste layer was about 1 m and that of the soil cover was about 15 cm.
- The longitudinal gradient of surface of waste was steeper than planned.
- The latitudinal gradient was not so steep.
- The existing landfill compacter made in Germany was not in use.

Photo 1.1 Sisdol Landfill Site (September 2006)

(2) Daily soil cover

- According to local staff, daily soil cover had been applied by means of soil locally obtained.
- The soil used for cover was cohesive soil and the permeability of soil was supposed to be low.
- Some parts of surface of dumped waste were not covered by soil. It was considered to be a cause of odor. (Refer to Photo 1.2).
- It was supposed that application of cell method might be one of reasons of infiltration of air and water to the waste layer.
- According to local staff, the soil had occupied about 30% of the waste layer in volume, and recently the ratio had been reduced to less than 20%.

Photo 1.2 Surface of Soil Cover

(3) Condition of gas ventilation facility

- Gas ventilation facilities were formed by used tires and the perforated PVC pipe of which inner diameter was 15cm. The inner diameter of tires was 35 to 40cm. It was observed that some tires had been filled with about 10cm stones and some tires hadn't. (Photo 1.3)
- It was confirmed that the lumps of clay soil, which looked like stones, had been mixed in the filled cobble stones. The lumps of clay were easily broken by hit.
- It was assumed that the some gas ventilation facilities did not work where the leachate retained around the pipe (Refer to Photo 1.4).
- Gas generation was not detected at some gas ventilation pipes by hands. Some pipes of the gas ventilation facility had been blockaded, which was also identified by the result of

monitoring of methane gas emission as shown below.

Photo 1.3 Gas Ventilation Facility

Photo 1.4 Condition of Gas Ventilation Facility

(4) The result of measurement of methane gas

- The result of measurement of methane gas generation is shown in Figure 1.1.
- Maximum value was 28.0%, while minimum value was 1.2%, which suggested that some of the gas ventilation facilities were blockaded. It is recommended that the improvement of the blockaded part should be prioritized and the other facilities should be gradually improved.
- Except some pipes supposed to be blockaded, there was a trend that methane concentration at the monitoring points in the downstream was lower than those at upstream. It is assumed that the fresh air came into the ventilation facilities from the end of leachate collection pipe. The methane concentration was diluted by fresh air. Therefore, it was concluded that air ventilation was working to some extent since air inflow from the leachate collection pipe was confirmed.

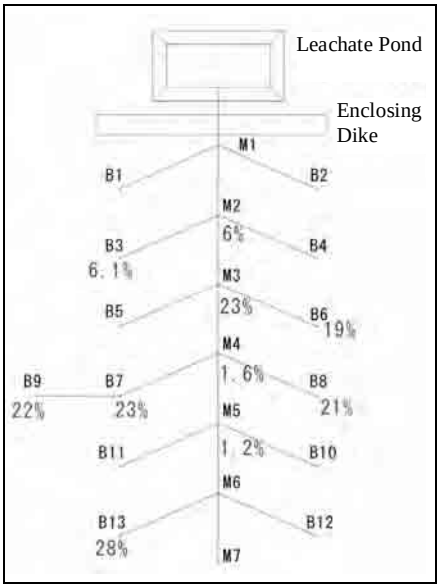


Figure 1.1 Result of Measurement of Methane Gas Generation

- It is said that the explosion limit of methane gas is 5.3 - 14.0%. Dangers of fire as well as explosion were recognized at the site. It should be reminded that strict control of flames and other sources of ignition would be required.
- Judging from detection of methane gas, hydrogen sulfide gas was considered to be generated at the site as well. It is also necessary to take appropriate cares for these hazardous gases.
- As only concentration of methane gas was measured, it could not be concluded whether inside of landfill site was aerobic or non-aerobic. It is necessary to measure the

generation of other gases such as carbon dioxide and oxygen.

- Assistant Professor Ayako Tanaka of Fukuoka University kindly provided the following comments based on the result of this site survey.

"It is assumed that the detection of methane gas indicates methane fermentation. However, it is required to measure carbon dioxide and oxygen to confirm whether the condition in landfill is non-aerobic or not. We can conclude that the condition in landfill is semi-aerobic if oxygen is detected and the carbon dioxide concentration is higher than methane concentration. On the other hand, it can said that the reaction is in transition period from hydrolysis stage to methane fermentation stage if oxygen is not detected and the carbon dioxide concentration is higher than methane concentration.

1.4 Proposals for Improvement of Landfill Site

(1) Improvement of Gas Ventilation Facility

- The gas ventilation facility should been improved with prioritization of (i) the blockaded parts and (ii) the part connecting with main collection pipe directly.
- There were some pondings that rainwater and leachate retained in the landfill area and there were retention pond for leachate circulation at the lowest place next to enclosing dike. Before the restart of operation after improvement, it is necessary to remove a part of soil cover which is supposed as interception layer. It is also to be confirmed whether leachate ponding in operation lot are eliminated. The parts would become interception layer of air and leachate, if those poundings will be remained and waste will be dumped on the pondings.
- The generation of methane gas and hydrogen sulfide was expected during the rehabilitation work of gas ventilation facilities. For implementing this kind of work, the following should be remembered.
  (i) Prohibit people from entering the holes in the waste
  (ii) Prohibit using the fire during the work
  (iii) Train the staff to be involved in the work to make them understand and prepare for the danger of hazardous gas.
- Measures for improvement are shown in the Figure 1.2 and 1.3.

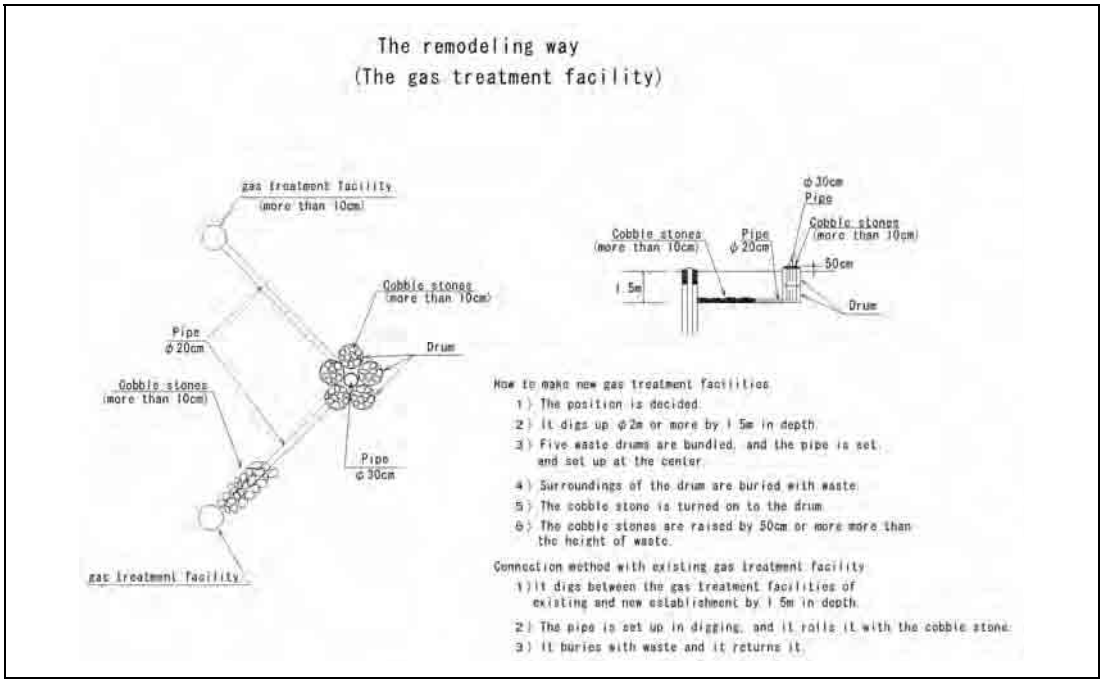


Figure 1.2 Improvement Method of Gas Ventilation Facility (1)

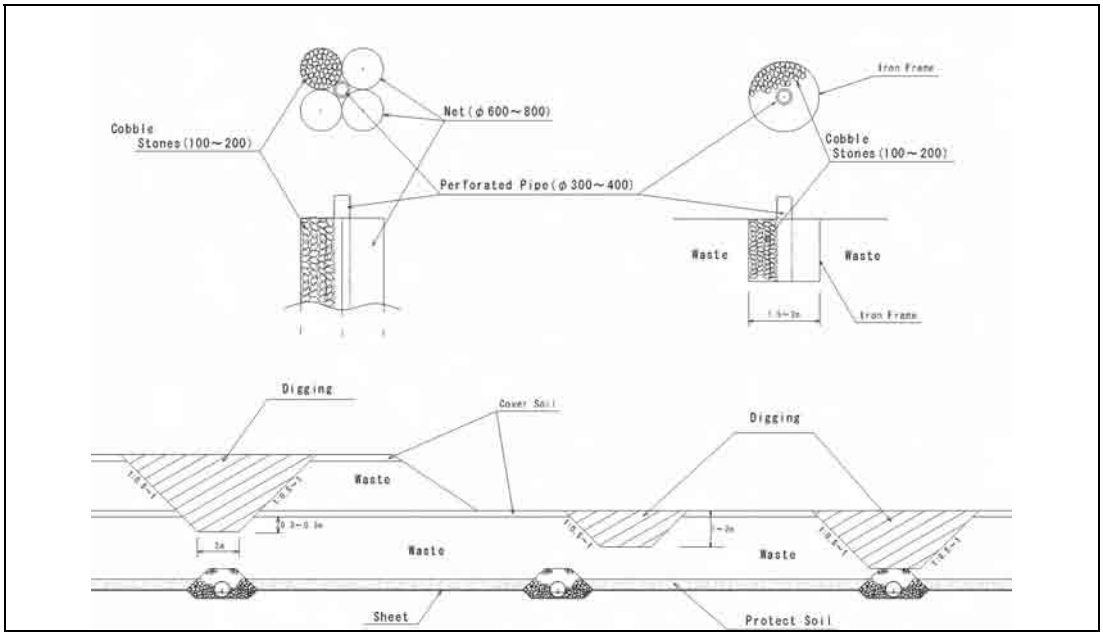


Figure 1.3 Improvement Method of Gas Ventilation Facility (2)

(2) Improvement of Landfill Method and Daily Soil Cover

- Since the cell method of landfill had been adopted, the layer of soil cover might inhibit the penetration and distribution of water to enhance semi-aerobic condition of waste layer although the daily soil cover is important to control 1) odor generation, 2) waste scattering and 3) annoyance of vermin generation.
- It could be considered to remove partial or all soil cover of the landfill area before dumping new waste on the layer. In addition to keeping the semi-aerobic condition, this could lead to reduce soil volume and then extend lifetime of landfill site by reusing the removed soil cover material.
- Method mentioned above can be adopted not only for the cell method but also the sandwich method. (Figure 1.4 and 1.5)

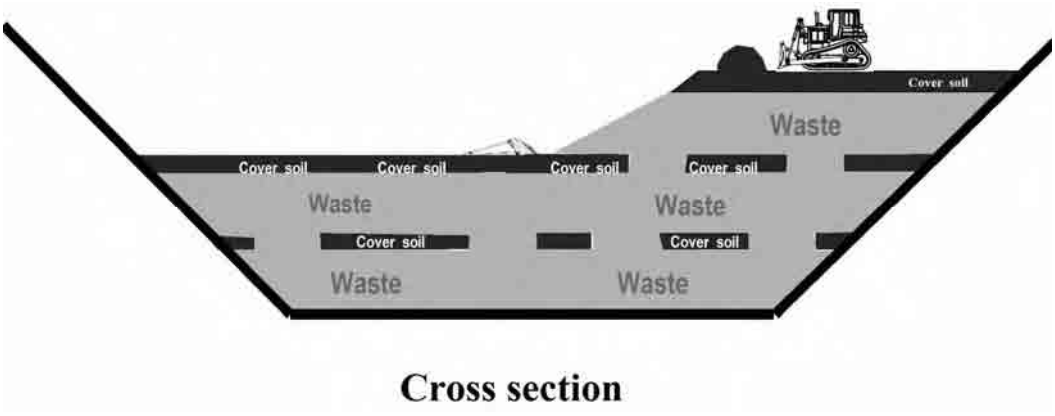


Figure 1.4 Proposed Measure for Sandwich Method of Landfill

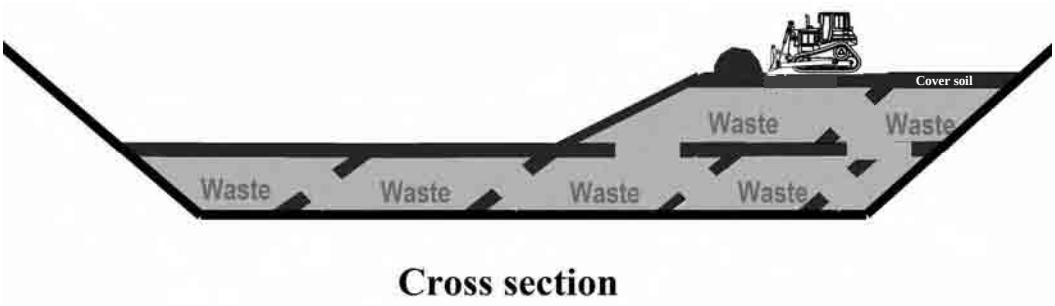


Figure 1.5 Proposed Measure for Cell Method of Landfill

(3) Appropriate Plan of Rainwater Drainage

- It is necessary to develop the appropriate plan of rainwater drainage to reduce amount of leachate.
- Judging from the record of monthly precipitation, the rainfall intensity of Kathmandu is higher than that observed when it is shower in Japan. Since clay soil has been applied as soil cover material, quick draining of the rainwater by appropriate drainage for the

high intensity rainfall would enable considerable reduction of leachate volume in the rainy season.

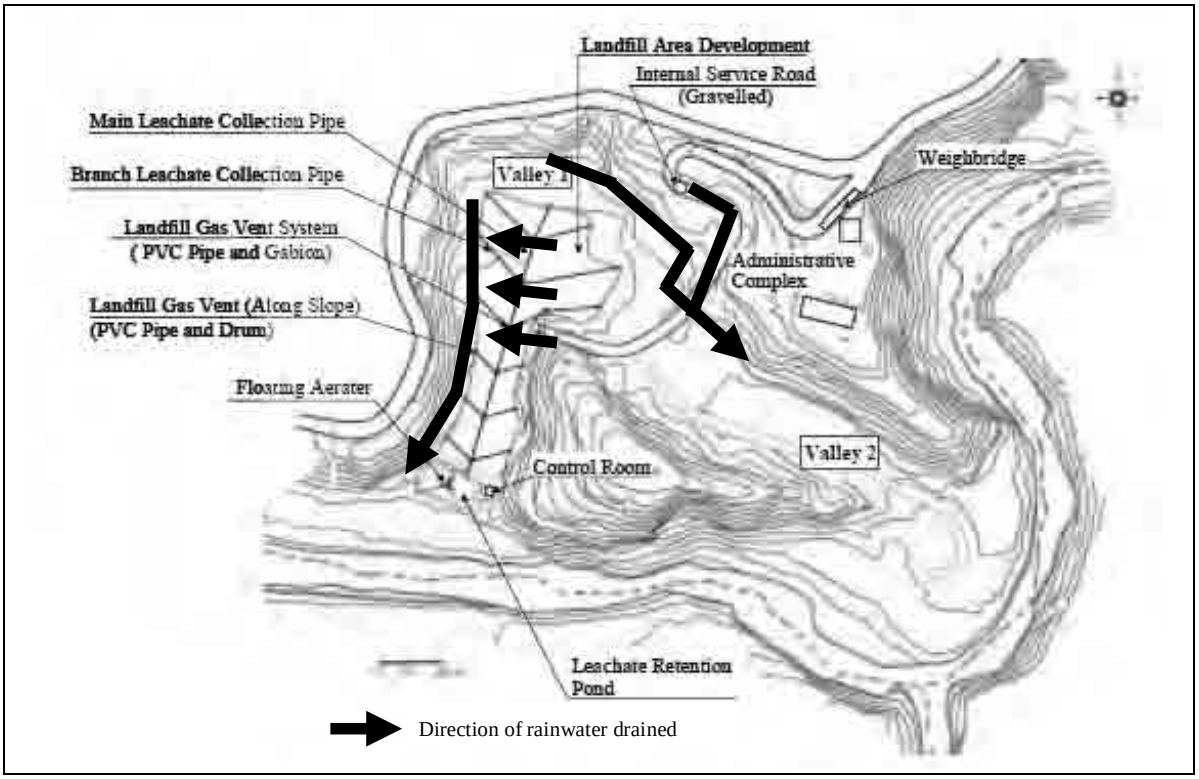


Figure 1.6 Proposed Plan for Rainwater Drainage

- Precipitation in the field should be considered to develop the rainwater drainage plan, rainfall could not be experienced during this site survey. The rough rainwater drainage plan was proposed as shown in Figure 1.6. Local topography and other information should be considered in the plan.
- If the proposed plan will be applied, the rainwater from the access road will be flowed into the area of Valley 2. Accordingly, it is necessary to develop other rainwater drainages for bottom liner during the construction of Valley 2.
- It is also important to landfill in the designed height to drain the rainwater as planed. In order to landfill as designed, it is recommended to use the makers or indicators as shown in Figure 1.7.
- Figure 8 shows the example to develop a simple drainage in the site. It is necessary to try to reduce the leachate and to drain the rainwater by development of rainwater drainage, which should be the most effective method according to the field condition.

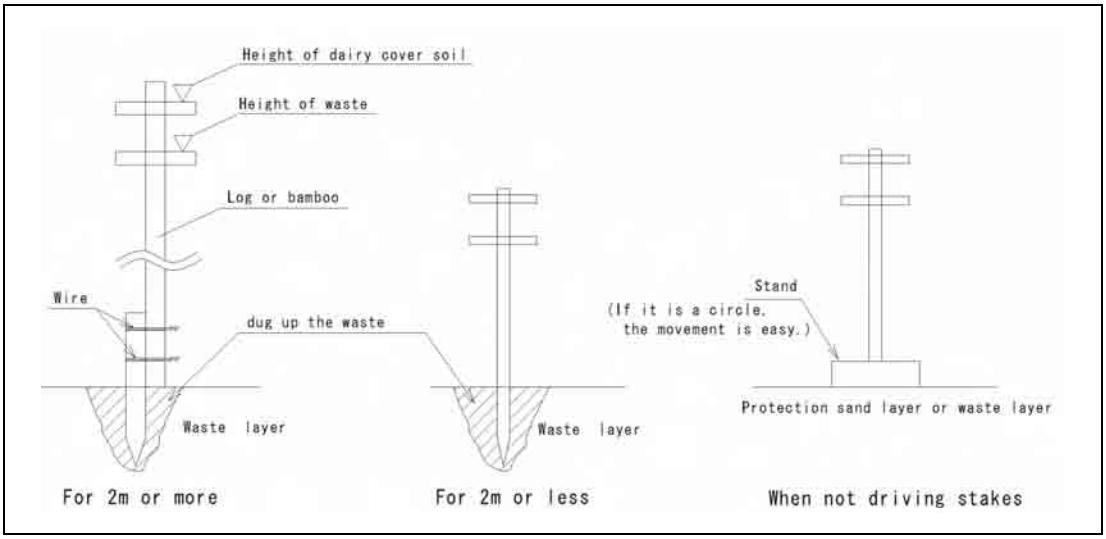


Figure 1.7 Method to Indicate Designed Height of Waste Dumping

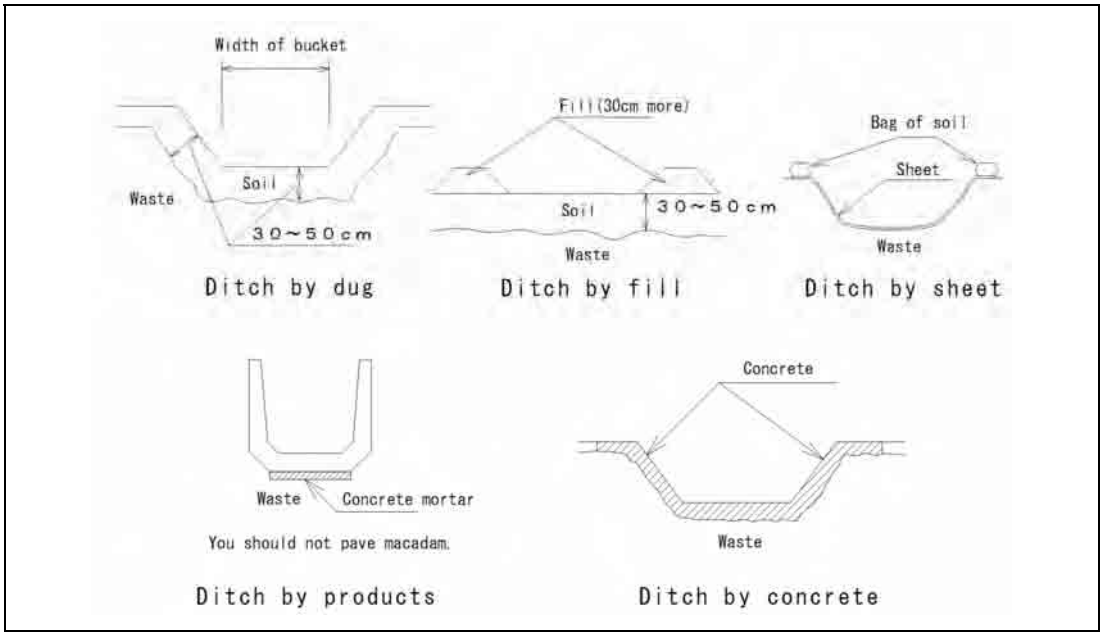


Figure 1.8 Development of Simple Drainage for Rainwater (Example)

L-2 Second Training for Improvement of Operation of Sisdol S/T-LF (December 2006)

2.1 Schedule of Second Training

The second training in December 2006 was conducted as shown in the table below:

Month	Day	Activities	Remarks
December 2006	11	Kick-off meeting with counterparts, SWMRMC and KMC	
	12	Instruction of operation and maintenance	
	13	Improvement of gas ventilation facility	
	14	Holding site meeting, and training for leveling and installation of finishing stakes (height markers)	
	15	Presentation of operation and maintenance of landfill in Fukuoka City	

2.2 Conditions of Sisdol S/T-LF

At the time of training in December 2006, the conditions of Sisdol S/T-LF were as follows:

- Waste transportation to Valley1 was just resumed after around five months suspension of the waste receiving.
- Amount of solid waste transported to the site was approximate 350 ton/day. It was estimated that 310 ton of waste was transported from KMC and 40 ton from LSMC.
- Three units of D4 bulldozers whose weight were around six ton were allocated to the site, but one was out of order. A wheel excavator was available at site, while a landfill compactor was out of order.
- The leachate retention pond was almost full of black color leachate. The aerator was not operated regularly because of lack of electricity, but leachate was circulated back into the operation lot.
- The leachate which was removed from the leachate retention pond for de-slugging was stored at the temporary pond excavated along the river.
- The dumped waste layer was around 2 m in depth. It was observed that part of dumped waste surface was not covered by soil. KMC were planning to implement final soil cover when waste layers would be settled after subsidence.
- It was explained by counterpart that eighty percents of construction for Valley 2 had been completed. It was expected that land formation would be completed in a month while that all construction work would be completed in two months. The procurement of equipment for aeration system had been behind the schedule.

- It was planed that the landfill operation of Valley 2 would be started by suspending the operation of Valley 1 as soon as the construction of Valley 2 is finished.

2.3 Kick-off Meeting

Training items were discussed at the kick-off meeting on December 11, 2006 as follows:.

- Rainwater could not be clearly separated from the waste as well as leachate because leakage of leachate was found and surface of the waste was not covered with soil completely
- KMC was planning to develop drainage when they would use Valley 2.
- Improvement of gas ventilation facilities was decided to be focused on by this training.

Photo 2.1 Kick-off Meeting

2.4 Training for Improvement of Operation and Maintenance of Sisdol S/T-LF

(1) Instruction of Maintenance of Equipment

The following significances of maintenance were highlighted to the operators at the site.

- Extend the lifespan of equipment as much as possible
- Reduce the total cost for repair of equipment by daily check and early detection of malfunction
- Reduce the time of work suspension to be caused by equipment troubles

The current ordinary maintenance practices done by the operator were confirmed as follows:

- Engine oil and coolant water were checked daily
- Cover of engine room was missing
- Damage with oil lines, oil leakage from engine room and bottom of equipment were detected.
- Lack of a part of crawler track of bulldozer
- Galling of driving sprocket

Photo 2.2 Instruction of Maintenance

- No cleaning work in daily maintenance

It was recognized that operators had acquired some extent of the maintenance knowledge. In order to increase their practical knowledge of the maintenance, the follow were instructed by the Study Team including maintenance of the bulldozer conducted together with the supervisor and operators of the site. Daily and monthly checklists for the equipments were also provided.

* Maintenance at the beginning of daily work

- Check of conditions of the engine oil and coolant water
- Detecting oil leakage in lines, external damage and missing parts

* Maintenance at the end of daily work

- Cleaning of equipment
- Check of missing part or parts to be replaced

It was considered that corrosion would occur due to continuous wet condition because waste sticking to underbody was not removed and cleaned in daily maintenance. It was also pointed that galling of driving sprocket would result in big expense for the repair. Therefore, a swamp type of bulldozer was recommended since the body of the bulldozer sinks during the landfilling works.

(2) Improvement of gas ventilation facility

This training was intended not to solve current blockage in gas ventilation facilities but to avoid causing blockage in the facilities and waste layers to be developed in future. The following conditions were confirmed before the training.

- The vertical gas ventilation system was developed by vinyl chloride pipes, with inner diameter was 15 cm, located at center of facility and used tires of vehicles equipped to encircle the center pipe. The inner diameter of the used tires was around 35-40 cm. Between the tire and pipe, rocks, those diameter was around 10 cm, were filled.
- Blocks of clay look like rocks were filled in the facility, which were not appropriate for gas ventilation facility because they are easy to break even with small impact or moisture.
- Ponding leachate was observed close to the gas ventilation facility, and gas emission was not detected at some vertical gas ventilation pipes. Many pipes did not stand exact vertically. Therefore, it was considered that the some facilities were not functioning well manly due to the bad connections of vertical pipes.

In order to improve the above situations, the following three improvement options were proposed and tried as countermeasures:

Improvement Option-1: Modification by foraminate drums and rocks (gas ventilation pipe B8)

The gas emission and ventilation was not detected at the mouth of the pipe B8. The base of the pipe was excavated by 3m from the ground level (G.L.). Then, pipe and tire was removed and new pipe and drums were installed to renovate the ventilation facility. (Refer to Photo 2.3, 2.4, 2.5)

[Remarks for the implementation]

- The base was excavated after checking the function of ventilation. During the excavation, the pipe was cleaned with high pressure water washer.
- Wastes were observed between tires and pipes which seemed to obstruct gas ventilation.
- Layer of clay, which was installed at the temporary closure of landfill in September 2006, was observed at the level of G.L. -2m.
- There was a space for leachate stream in the waste layer because leachate was seen in the pipe at G.L. -3m
- Although it was planed to use five drums for one vertical ventilation facility at the beginning of training, the actual improvement was implemented by only one drum due to availability of drums and rocks at the site.
- The rocks were accommodated around the vertical pipe above G.L. The diameter of pile of rocks above G.L. should be more than 2 m. (Refer to Photo 2.6)
- It took rather long time to make holes of drum and man power was required to prepare foraminate drums.

Photo 2.3 Before Improvement

Photo 2.4 Excavation to GL -3.0m

Photo 2.5 Replacing Facilities

Photo 2.6 After Improvement

<u>Improvement Option-2:</u> Installation of materials by excavator (gas ventilation pipe M4)

The following steps were taken for the improvement.

- Step1: The existing facility was removed and the base was excavated before trial (Refer to Photo 2.7).
- Step2: Develop small dike of waste circumscribing pile of rocks to raise a pile.
- Step3: Fill rocks into the space between the dike and pipe (Refer to Photo 2.8).
- Step4: Repeat above two work steps.

[Remarks for the implementation]

- It should be reminded that the diameter of pile of rocks to be accommodated for the circumference of vertical ventilation pipe should be more than 2m.
- It was also instructed that, when gas ventilation facility would be developed, the height of rocks pile for the circumference of pipe should be higher than G.L. +50 cm.

Photo 2.7 Excavation (Before Improvement)

Photo 2.8 After Improvement

Improvement Option-3: Modification by means of connected drums (gas ventilation pipe B6)

The following steps were taken for the improvement.

- Step1: Removed existing tires and pipes above G.L.
- Step2: Cleaned the remained vertical pipe to be linked to new pipe by high pressure water washer
- Step3: Linked new pipe with remained vertical pipe
- Step4: Cleared the ground around the facility and prepared for installation of drums
- Step5: Combined five drums to the vertical pipe located at the center.
  * Six to seven drums may be necessary considering the condition observed after implementation of Improvement Option-3 with five drums although only five drums were used in this training. It is better to secure more width rocks.
- Step6: Filled rocks in drums and space between the drum and pipe.

Photo 2.9 Introduction of Option-3

Photo 2.10 After Improvement

(3) Site Meeting

The following two aspects for the landfill management are to be considered to reduce amount of leachate. One is management of waste height buried at the site. The other is development of drainage for rain water. The present height of operation lot has to be realized to manage these two points. Therefore, site meeting among planning staff and supervisor of site is useful to make consensus for landfill management. Equipment operators are also requested to be present because their experience and knowledge in actual operation work would be helpful to decide practical plan.

Photo 2.11 Site Meeting

[Discussion and Instruction in site meeting]

An operation plan of landfill lot including two options was discussed at the site as follows:

- Option-1: The landfill operation of Valley 1 will be suspended and operation of Valley 2 will be started as soon as construction of Valley 2 is finished. When the heights of waste at both valleys will reach same, both valleys will be used.
- Option-2: Valley 2 will be used after completion of Valley 1.
- Staff concerned with landfill management and operation had selected Option-1. It was therefore instructed that intermediate soil cover should be implemented before start of operation of Valley 2 after suspension of Valley 1.
- It was also explained that both long-term and short-term plan should be developed for landfill management. Planning of drainage of rain water should be prepared as well.

(4) Training of leveling, installation of finishing stake showing height for waste burying

To understand the life expectancy of the landfill, progress of waste dumping in terms of landfill capacity should be predicted and monitored based on the amount of waste hauled at the site. It is responsibilities of supervisor of landfill operation to prepare land formation for access road, appurtenant works such as intermediate and final soil cover.

At the site, the height of landfilled waste had not been managed. Training of leveling was conducted to enhance controlling the shape of landfilled waste as a part of landfill management. Besides, waste height makers were installed so that the operators understand planned height of waste dumped. Some workers showed concern that height sign could not keep being correct because waste layer would subside. In corresponding to this, it was explained that height sign would be referred as relative standard for operation of waste dumping. The following training were provided by the Study Team.

- How to use and operate of the level
- How to use leveling staff
- How to write field note
- Actual leveling work
- Installation of finishing stakes

Photo 2.12 Training of Leveling

Photo 2.13 Installation of Finishing Stake

Photo 2.14 Fixing Finishing Stake

Photo 2.15 Finishing Stake Installed

(5) Introduction of operation and maintenance of landfill in Fukuoka City

At the end of a series of training, operation and maintenance of landfill in Fukuoka City was introduced to the counterparts. It was expected the counterparts would refer the case of Fukuoka City to draw the direction of landfill management of Sisdol S/T-LF as well as in future landfill. The following materials were provided for the intoriduction.

- Procedure of operation and maintenance of landfill in Fukuoka City
- Items in the work manual in Fukuoka City
- Video for works of waste management

2.5 Recommendations

(1) It is recommended that a landfill manager, technical manager, and work supervisor should be appointed at the site since the weakness in enforcement of landfill management and demarcation of responsibilities among organizations concerned were recognized in the course of this training. Besides, it is also recommended that the operation manual defining the basic policy, necessary works and personnel responsible of landfill management, which was developed during the pilot project phase of the study, should be utilized.

(2) Plan of waste dumping at the site should be prepared shortly. The reasons for this are as follows:

- Currently, there was around 70 m distance between the unloading location from the waste transportation vehicles and actual operation lot. It was required that the bulldozer had to move unloaded waste the distance up to operation area. It is therefore recommended that internal access road up to operation lot should be developed in order to reduce cost for equipment fuel as well as amount of cover soil.
- The surface of operation area after burying of waste need to be slightly gradient slope to drain surface water.

(3) Type of heavy equipment to be used for landfill operation can be reviewed to make the operation work effectively. Specifically, replacement of one existing bulldozer and wheel excavator to a crawler excavator. The reasons for this are as follows:

- A wheel excavator has a difficulty to access to the operation lot because ground of the site is cohesive clay.
- A crawler excavator is useful for various operation and maintenance activities at the site such as construction of drainages of rain water, establishment of finishing stakes, earth cutting for the access road.
- Adoption of the crawler excavator to perform Improvement Option-2 for gas ventilation facility will contribute to save running cost, implement maintenance work at the site, and secure safety working condition of staff.

(4) Nets to prevent waste from being flown out to surrounding areas should be installed. Required cost can be reduced by utilize material available at local market.

Photo 2.16 Site Requiring Preventive Net

Photo 2.17 Case of Simple Net Installed

(5) Cost reduction for continuation of maintenance of gas ventilation facility

Blockage in gas ventilation pipes had been recognized at Valley 1, but it is difficult to improve the function in lower waste layer that had been buried. One is the measure for new waste layer, the other is improvement of horizontal gas ventilation facilities that was counterparts interested. Whichever measure will be taken, cost reduction should be

considered for maintenance of gas ventilation facilities because pipes may be damaged by outer impact as shown in Photo 2.18. The pipe whose price is reasonable and which is made of flexible material is preferable to be adopted (Refer to Photo 2.19).

The following table shows comparison of pipe prices of, which are cases in Japan.

Table Comparison of Price of Product (Reference: Price in Japan)

Product	Diameter	Unit Price
Vinyl chloride pipe (foraminate)	150 mm	JPY2,600/m
High density polyethylene (foraminate)	200 mm	JPY1,200/m

Photo 2.18 Damaged Ventilation Pipe

Photo 2.19 Case in Fukuoka City

L-3 Third Training for Improvement of Operation of Sisdol S/T-LF (March 2007)

3.1 Schedule of Third Training

The third training in Mach 2007 was conducted as shown in the table below:

Month	Day	Activities	Remarks
March 2007	2	Meetings with SWMRMC and JICA Nepal office	
	3	Inspection of Sisdol Landfill Site	
	4	Indoor Workshop	Participants of the other countries were joined
	5	Preparation of landfill height markers for the first layer in Valley 2	ditto
	6	Preparation of bamboo gabion for gas ventilation facility, improvement of gas ventilation facility in Valley 1, and instruction of the first landfilling layer in Valley 2	ditto
	7	Installation of landfill height markers, and leachate re-circulation bed for Valley 1	ditto
	8	Installation of eachate collection drainage and landfill height markers for the landfill area in Valley 1, and improvement of gas ventilation facility in Valley 1	ditto
	9	Surface arrangement and final soil cover of landfill area in Valley 1 Wrap up meeting	ditto
	10	Report preparation	
	11	Final soil cover of landfill area in Valley 1, and improvement of gas ventilation facility in landfill area in Valley 1	
	12	Installation of landfill height marker of landfill area in Valley 1, and preparation of gabions for gas ventilation facility in Valley 2	
	13	Preparation of gabions for gas ventilation facility in Valley 2	

Note: Participants of the other countries were from Mongolia, Vietnam, Pakistan, Sri Lanka, Bangladesh, and Vanuatu.

3.2 Condition of Sisdol S/T-LF

At the time of training in March 2007, the conditions of Sisdol S/T-LF were as follows:

- A part of gas ventilation pipe has been clogged. The gas ventilation pipe of vertical and longitudinal direction has been installed on the waste layers under which gas ventilation pipe is clogged as the countermeasure (Refer to Photo 3.1).
- The bamboo and steel wire have been used for the gabion as a case material of cobble stones for gas ventilation facility, which has been considered by Nepalese side (Refer to Photo 3.2).

- On-site road has been prepared so that collection vehicle can go to dumping area for unloading effectively.
- Bulldozer operates on the new gas ventilation pipes, which may cause the damage of the gas ventilation pipe of vertical and longitudinal direction. The cushion layer by waste or other material which is more than 2 m height, is needed to protect the pipes.
- Footage of bulldozer has been improved based on the previous instruction (Refer to Photo 3.3)
- Regarding Valley 2, the construction of landfill area has been finished but aeration pond is under construction and the schedule is delayed (Refer to Photo 3.4)

Photo 3.1 New Gas Ventilation Facility

Photo 3.2 Bamboo Gabion

Photo 3.4 Landfill Area of Valley 2

Photo 3.3 Foot Condition of Bulldozer

3.3 Indoor Workshop

At the beginning of a series of training, the indoor workshop was held in order exchange information among the Nepalese counterparts, participants from outside Nepal (Mongolia, Vietnam, Pakistan, Sri Lanka, Bangladesh, and Vanuatu) and the Study Team. Main contents of indoor workshop were described as follows

- Introduction of current situation of SWM in the Kathmandu Valley and the presentation by participants from each country and presentation of the Study
- Presentation of 1) previous work of improvement of Sisdol short-term landfill site operation, 2) the contents of training (Installation of landfill height marker, leachate

circulation bed, gas ventilation facility) and 3) introduction of case study of landfill method in Fukuoka City including leachate purification system without electricity.

3.4 Improvement of Sisdol Landfill Operation

A series of training for improvement of operation of Sidol S/T-LF was conducted as follows:

(1) Maintenance and arrangement of heavy equipment

- Abrasion of the driving wheels of landfill compactor occurred due to slips during slope traveling (Refer to Photo 3.5). It would be difficult to carry out compaction of the waste on the slope. It had been indicated that the maintenance would be required. In addition, chopper used in Fukuoka was introduced for driving wheel (Refer to Photo 3.6).
- The sprocket of driving wheel of bulldozer should be carefully checked to maintain and exchange it in the early stage to make the life-span of bulldozer longer (Refer to Photo 3.7).
- An excavator was needed for arranging the surface with flat bucket.

Photo 3.5 Abrasion of Driving Wheel

Photo 3.6 Chopper of Driving Wheel (Fukuoka)

Photo 3.7 Changed Sprocket

(2) Landfill Operation at Valley 1

- Landfill height markers of current landfill layer and the final layer above final soil cover had been installed with consideration of current landfill operation plan, i.e. longitudinal

gradient is 2% and 1:3 slope near the embankment (Refer to Photo 3.8). In the process of the installation, how to operate leveling machine was instructed (Refer to Photo 3.9).

- It was also instructed that waste dumping should be carried out from down stream of valley and depth of waste layer should be deep to prevent increase of ratio of soil in layer.

Photo 3.8 Installation of Landfill Height Marker

Photo 3.9 Level Measurement

(3) Installation of leachate re-circulation bed

- In order treat leachate effectively, the re-circulation system was installed by utilizing the pump and re-circulation bed (4m x 4m, depth 1m). Around the functioning gas ventilation pipes, recirculation bed was installed by using cobble stones to infiltrate scattered leachate into waste layer through the stones together with bamboo gabion (diameter 2m) and four PVC pipes with holes (height approx. 0.2m) (Refer to Photo 3.10 to 3.12). Infiltration of sprayed leachate on the bed through the cobble stones was expected as a trickling filter.

Photo 3.10 Check of Clogging in Pipe

Photo 3.11 PVC Pipe in the Gabion

Currently, leachate flow into completion area of landfill activity as surface water. To prevent the surface leachate, the drainage of leachate on surface landfill layer was installed into the re-circulation bed (Refer to Photo 3.13 and 3.14).

Photo 3.12 Leachate Re-circulation Bed

Photo 3.13 Leachate Stream on the Surface

Photo 3.14 Construction of Drainage

(4) Improvement of gas ventilation facility

- Bamboo gabion had been adopted for gas ventilation facility. The diameter of the gabion was instructed more than 2m. To share the knowledge with the guests from other countries, the Nepalese counterparts introduced to make the bamboo gabion (Refer to Photo 3.15 and 3.16).
- Bamboo, drum and steel gabions were mainly used for this improvement work (Refer to Photo 3.17 to 3.18).

Photo 3.15 Preparation of Gabion

Photo 3.16 Bamboo Gabion Prepared

Photo 3.17 Steel Gabion Method

Photo 3.18 Drum Gabion Method

(5) Final soil cover

It is important to prevent of infiltration of the rain water and to drain the rainwater outside of landfill area to reduce the leachate amount. Final soil cover was carried out for the area near the embankment where the landfill had been completed with the instruction of the Study Team as follows: (Refer to Photo 3.19 and 3.20).

- Depth of final soil cover should be more than 50 cm that is current designed value to prevent the rainwater infiltration.
- Cell method should be adopted to prevent rain water infiltration.
- The protection sheet to prevent rain water should be installed after the final soil cover.

Photo 3.19 Final Soil Cover (No. 1)

Photo 3.20 Final Soil Cover (No. 2)

(6) Landfill Operation at Valley 2

- Regarding the first landfill layer, it was instructed that landfill operation should be carried out from upper stream to down stream and the first waste layer should be 2m depth. After accomplishment of the area near the embankment, on-site road on the left bank was instructed to be used for landfill operation of the second waste layer from downs stream to upper stream.

Photo 3.21 On-site Road of Left Bank of Valley 2

- It was also recommended that on-site road (8m width, 30cm height) should be constructed As the progress of landfill operation. In addition, the soil with gravel but not only soil can help the vehicles to be easy to drive on the on-site road during the rainy season in order to avoid the slip.
- The leachate collection pipe was concerned due to collision with heavy equipment operation. To solve the problem, the depth of waste layer was instructed to be secured more than 2 m. Two meter height of movable height markers made of bamboo were installed (Refer to Photo 3.22 and 3.23).

Photo 3.22 Preparation of Height Marker

Photo 3.23 Height Markers Installed

- It was recommended that, in the case of difficulty of preparation of enough space for unloading platform, only the dump trucks which has dumping function utilize the landfill are of Valley 2, and the other manual unloading trucks should utilize the landfill area of Valley 1 (Refer to Photo 3.24 and 3.25).

Photo 3.24 Condition of Waste Transportation in Site

Photo 3.25 Unloading by Dump Truck

- There were one landfill compactor and one bulldozer (4t) at the site, but they were not enough for proper operation. It was instructed as temporary measure that the landfill compactor should be used for Valley 1 and the bulldozer should be used for Valley 2 considering the ground conditions (Refer to Photo 3.26).

Photo 3.26 Utilization of Bulldozer

- The compaction was carried out by the landfill compactor to stabilize the ground on the landfill layer. In addition, allocation of controller for waste collection vehicle was suggested to prevent downfall from the shoulder of on-site road (Refer to Photo 3.27 and 3.28).

Photo 3.27 Landfill Compaction by Landfill Compactor

Photo 3.28 Allocation of a Guide

- As for gas ventilation facility, the diameter of gabion was instructed to be more than 2 m to prevent clogging gas ventilation pipes same as Valley 1 (Refer to Photo 3.29 and 3.30).

Photo 3.29 Existing Gas Ventilation Facility

Photo 3.30 Improved Gas Ventilation Facility

3.5 Wrap-up meeting

The wrap up meeting was held at the end of a series of training inviting the participants from other countries. Opinions were exchanged and the training activities were reviewed as follows:

(1) Issues regarding Sisdol short-term landfill site operation

- Difficulty of procurement of resource materials and equipment due to the requirement of tender process.
- A facility manager has to handle not only technical matters but also social matters considering countermeasure of regarding the relation with surrounding residents.
- An excavator is needed for landfill operation.

(2) Confirmation of Instruction Contents and Items to be Considered

【Valley 1】

- Importance of landfill height management
- Landfill compaction of slope areas instead of landfill compacter by utilizing an excavator with flat packet.
- Consideration of thickness of final soil cover (adaptation of suitable thickness of more than 50 cm)
- Preparation of sections for landfilling
- Preparation of vinyl sheet for rainwater drainage on the final soil cover
- Utilization of leachate re-circulation bed and its extension according to the progress of landfill operation.
- Landfilling from downside to upper

【Valley 2】

- Landfill operation of first landfill layer from upstream to downstream. After arrival at embankment of first landfill layer, the left bank road can be utilized as on-site road.
- Construction of on-site road of 8m width and 30 cm height as the progress of landfill operation of Valley 2. The on-site road should be also constructed with soil including sandy material or gravel for the rainy season.
- Temporarily closure of landfill area of Valley 2 until the completion of construction of leachate retention pond for prevention from inflow of leachate to the pond. During temporary closure period, final cover should be carried out to prevent from exposure of dumped waste.

3.6 Recommendations

- It is strongly recommended that stationed technical manager should be appointed permanently who will prepare the landfill plan, rainwater drainage plan and other related plans.
- It is important to arrange the heavy equipment especially shoe type excavator.
- Operation manual should be used to identify landfill operation, maintenance and the direction regarding landfill plan.

Supporting Report M

Newsletter

CKV NEWSLETTER

No. 7
May, 2006

Clean Kathmandu Valley Study -Sapha Sahar Hamro Rahar-

Now The CKV Study has been entering into the Monitoring and Follow-up Phase!

Since the the CKV Study started in January 2004, various kinds of activities had been carried out by together with Nepalese counterpart personnel and the JICA Study Team. Many of pilot projects in the field of A) Improvement of collection and transportation, B) Promotion of waste minimization, C) Improvement of final disposal planning and operation, D) Promotion of public awareness and behavior change communication/ education, and E) Development of operation and management capacities, was conducted during the study period and Action Plans on solid waste management (SWM) of each of the five municipalities and Solid Waste Management Resource Mobilization Center (SWMRMC) were finally prepared. In the Action Plans, necessary activities in short-, mid-, and long-terms up to 2015 are proposed with its respective implementation plan in order to achieve the goal and target, then those activities are broken down into the Annual Work Plan (AWP) with responsible staff and necessary program based budgets.

AWP Monitoring Session

Water quality monitoring at leachate retention pond

Although capacity of the Nepalese counterpart for planning and management of solid waste had been developed through participating the CKV Study, further capacity development is needed to implement their Action Plans and AWPs effectively and continuously. So, it was agreed between Nepalese side and Japanese side to conduct Phase IV of the the CKV Study as a monitoring and follow-up to accelerate the driving force of SWM. The contents of the Phase IV are "monitoring and evaluation of progress of activities in the AWPs (Monitoring)" and "technical assistance for activities in the AWPs (Follow-up)".

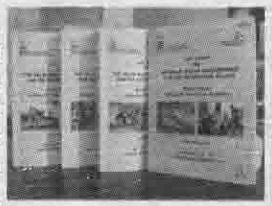
Follow-up Survey at Banchare Danda

As part of the Phase IV, a series of monitoring sessions of the respective AWPs are conducted by taskforce members of each of the five municipalities and SWMRMC and the JICA Study Team jointly to assess progress of the activities so that the monitoring results will be reflected on planning and implementation of future activities. Technical assistance for collection and transportation, waste minimization and solid waste data management at each or designated municipality is being provided by the JICA Study Team. Because social and environmental considerations are very important for facility development, technical assistance for the EIA study on a long-term landfill site in Banchare Danda, Okharpauwa and for identification of environmental issues for planning of new transfer stations (T/S) in both KMC and LSMC are also being made in this Phase IV. Furthermore, technical support for operation of Teku T/S and Sisdol Landfill is another task of this follow-up activity. This monitoring and follow-up phase was launched in November 2005 and will be continued for about one year. Through the actual implementation of the AWPs, administrative and technical capabilities of SWM are expected to be improved. We do hope to work toghter to implement YOUR SWM Action Plans!

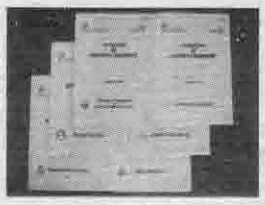
Loading and Unloading Practices in Teku T/S

Final Report of the CKV was Prepared!!!

Thanks to your cooperation and participation to the The CKV Study, final report of the Study was prepared and submitted to JICA Headquarters and then shipped and delivered to Nepal. Reports consist of Executive Summary, Main Report, Supporting Reports I and II, and respectively extracted Action Plan of each municipality and SWMRMC. Hundreds pages of the reports will make you understand what had been carried out during the CKV Study period since January 2004. We hope Action Plan proposed in the report based on the experiences through implementation of various pilot projects by the Study contribute to achieve the goal of CKV, "***Sapha Sahar Hamro Rahar***".



A set of Reports



Action Plans

Message from the Acting GM of SWMRMC

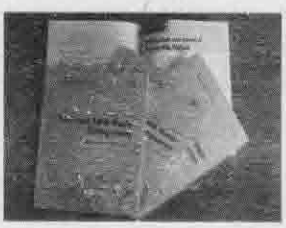
Government of Japan's assistance in solid waste management in Kathmandu Valley under the CKV Study has given definite direction towards the integrated and sustainable solid waste management system. The involvement of concerned personnel of municipalities and SWMRMC in preparing the Action Plans of their organizations is the most important characteristics of this study which focuses on the necessity and requirements of individual municipality that will lead to a sustainable solid waste management in the valley. Another important aspect of the CKV Study is technology transfer from Japanese experts to Nepalese counterparts during the entire study period from the identification of the pilot projects, their implementation to the preparation of the Action Plans.

Nepalese side are confident that one year Monitoring and Follow up phase will assist the municipalities for the implementation of Action Plans and provide necessary technical assistance during the implementation stage of Action Plan.

The best practices and experience of the Kathmandu Valley could be a good model and could be replicated to the other municipalities of Nepal for sustainable solid waste management system.

As a chairperson of TWG I would like to express my sincere gratitude to all the CKV team members (Nepalese and Japanese) for their hard working and successful completion of "The Study on Solid Waste Management in Kathmandu Valley".

Do you know the current Public-Private Partnership (PPP) practices in Solid Waste Management in the Kathmandu Valley?



PPP Operational Hand book

Within the five municipalities of the Kathmandu Valley, a significant number of private and non-governmental organizations are playing a prominent role in SWM practices, especially in collection and primary transportation of solid waste. For example within KMC, approximately 30% of waste is being collected by such organizations; and also in other municipalities, various forms of such public-private cooperation exist. These organizations consist of a group of private enterprises, NGOs and CBOs, with various capacities and degrees of affiliation with the municipalities. Some of the NGOs and CBOs also promote waste minimization through community-based activities as part of their services.

The involvement of private or NGOs in SWM is beneficial to the municipality, since it reduces the financial burden of having to collect all waste generated within its borders.

Despite such on-the-ground developments, the institutional framework and procedures to promote and formalize such partnership between the public (i.e. the municipalities) and the private (i.e. the private and NGOs) actors in SWM have not been put in place in any of the municipalities. Such institutional framework and procedures for Public-Private Partnership (PPP) in SWM are necessary for the municipality to monitor and ensure the standard of private actors on one hand, and to minimize risks and safeguard investments of the private actors. Furthermore for the general public, clear guidelines on PPP and transparent procedures ensure equity in receiving SWM services. In other words, PPP arrangements should create a win-win-win situation for the public and private actors, and for the people of the Kathmandu Valley. The CKV Study, in view of the above, developed the "PPP Operational Handbook for SWM" in which we hope will provide the basis for the municipalities to move forward in formalizing the partnerships with the private actors, which they have already nurtured on-the-ground.

Message from the JICA Study Team in charge of Financial/Economic

Every public service has to be designed and implemented by comparing the level of the services and the necessary cost. Foregone cost is an important basic data to analyze existing SWM conditions, find problems and form appropriate plans. Accordingly, it is recommended that the SWM costs (personnel, operation/ maintenance, and capital), separated into the operation-wise (street cleaning, collection, transport and disposal) at annual basis, are to be kept as data file (cost per ton, per staff, per equipment, etc).

21 units Secondary Transportation Vehicles Have arrived!!!

Handing over Ceremony of Secondary Transportation Vehicles

Now, you have a strong transportation power to take collected garbage from KMC and LSMC to Sisdol Landfill in Okharpauwa. 21 units of secondary transportation vehicles, 18 extra containers and their spare parts were procured by Ministry of Local Development (MOLD) under the scheme of Japan's Non-Project Grant Aid. In those of 21 units, 17 units are allocated to KMC and 4 units to LSMC. The handover ceremony was magnificently held on December 21, 2005 at Teku Transfer Station in KMC, inviting Mr. T. Hiraoka, Japanese Ambassador to Nepal, and Mr. S. Yoshiura, Resident Representative of JICA Nepal Office.

New Transportation Vehicles

A container capacity is 15 cubic meter which can carry about 6 tons of waste per vehicle per trip. It is expected approximately 250 tons of waste, means 80 to 85 % of all waste collected from both cities, will be transported to Sisdol Landfill with 2 trips per day. The existing vehicles will cover the remaining part of the collected waste to be trasnsported to the landfill site.

A website of The CKV Study will be re-opened

Now The CKV Study website is under the improvement of its contents. New website will be re-opened soon including the introduction of the progress of the monitoring and follow-up phase of the CKV Study.

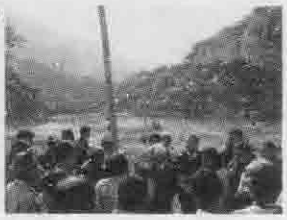
Website: http://www.mld.gov.np/swm/ckv/index.html

A workshop on Fukuoka Method was held

Professor Matsufuji is one of the founders of semi-aerobic landfill system and has wide experiences in developing this system in Japan and other countries.

On December 6, 2005 Professor Matsufuji of Fukuoka University and Mr. Sakai from Fukuoka City Municipality demonstrated the Fukuoka Method for sanitary landfill at Sisdol landfill site, as one of the activities of a 3 day workshop held by UN Habitat and HMG of Nepal. Around 80 participants watched as Prof. Matsufuji used bamboo pipes, old car tires and oil drums to show the method to achieve the Semi-areobic with low cost.

The CKV Study was also very pleased to receive their valuable comments and advice concerning means to improve the operation of Sisdol semi-aerobic landfill. Furthermore KMC and the Okharpauwa Local Committee explained to the participants on the operation of the landfill and the role of the Local Committee in monitoring this operation.



On-Site lecture by Dr. Matsufuji

Participants from other municipalities were impressed with the simplicity of developing the landfill system and its operation and we look forward to seeing in the near future less open dumping sites in Nepal and more semi-aerobic sanitary landfills.

Visit the The CKV Study Team

c/o Local Development Training Academy (LDTA)
P.O. Box:11980, Jawalakhel, Lalitpur, Nepal
Phone: +977-1-5555373 (direct) / 5521051 (Ext. 19)
Fax: +977-1-5555373 (direct) / 5521521 (c/o LDTA)
E-mail: nkswms@wlink.com.np

CKV NEWSLETTER

No. 7
Jestha, 2006

Clean Kathmandu Valley Study -Sapha Sahar Hamro Rahar-

सफा काठमाण्डौ उपत्यका (CKV) अध्ययन अनुगमन तथा अनुसरण चरणमा प्रवेश गरेको छ ।

सन् २००४ जनवरीमा शुरु भएको सफा काठमाण्डौ उपत्यका (CKV) अध्ययन अन्तर्गत बिभिन्न क्रियाकलापहरु ने पाली समकक्षिहरु र JICA अध्ययन टोलीको सयुक्त प्रयासमा भइ आएको छ । (क) संकलन तथा ओसार पसार कार्यको प्रगती (ख) फोहरमैला न्यूनीकरण कार्यको प्रबर्द्धन (ग) फोहरमैलाको अन्तिम टुंगो लगाउने बिषयमा योजना बनाउने र संचालन गर्ने बिषयको विकास गर्ने (घ) जनचेतना र व्यवहार परिवर्तन सचेतता शिक्षा (ङ) फोहरमैला व्यबस्थापन क्षमताको विकास अन्तर्गत बिभिन्न नमूना योजनाहरु नगरपालिकाहरु र फोहर मैला श्रोत परिचालन केन्द्रको कार्य योजना तर्जुमा गरियो । कार्ययोजनालाई अल्पकालिन, मध्यकालिन र दीर्घकालिन गरी सन् २०१५ सम्मको लागि बिभाजित गरिएको छ । ती योजनालाई बार्षिक कार्ययोजना (AWP) मा बांडी जिम्मेवार व्यक्ति र योजनामुलक बजेट समावेश गरिएको छ ।

AWP को अनुगमन समय

Leachate retention pond मा पानीको गुणस्तर अनुगमन

CKV अध्ययनको माध्यमबाट नेपाली समकक्षिहरुको फोहर मैला व्यवस्थापन तथा योजना तर्जुमा गर्ने क्षमता वृद्धि भएको छ तर निरन्तर र प्रभावकाली रुपमा बार्षिक योजना (AP) र बार्षिक कार्ययोजना (AWP) लाई लागू गर्न थप क्षमता वृद्धि गर्न आवश्यक देखिएकोले नेपाली र जापानी पक्ष बीच अनुगमन / अनुसरण गर्न Phase IV सञ्चालन गर्न निर्णय भएको छ । Phase IV अन्तर्गत बार्षिक योजना भित्रका कृयाकलापहरुको अनुगमन र आवश्यक प्राबिधिक सहयोग अनुसरण रहेका छन् ।

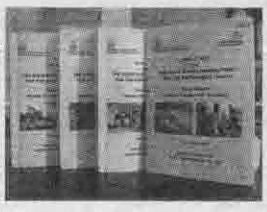
बञ्चरे डांडामा अनुसरण (Follow-up) तर्फ

Phase IV मा क्रियाकलापहरुको अनुगमनको निम्ति नगरपालिकाका र फोहरमैला तथा श्रोत परिचालन केन्द्रका कार्यदल र JICA अध्ययन टोली मिली अनुगमन कार्यहरु गरिएको थियो । ताकि अनुगमनबाट आएको निश्कर्षलाई आगामी कार्ययोजनामा लागू गर्न सकियोस । JICA अध्ययन टोलीबाट तोकिएको वा प्रत्येक नगरपालिकामा फोहर संकलन तथा ढुवानी, फोहर न्यूनिकरण र फोहरको तथ्यांक व्यवस्थापनहरुमा प्राविधिक सहयोग उपलब्ध गराइएको छ । बंचरेडांडा दीर्घकालिन ल्याण्डफिल साइटको EIA गर्नको निम्ति प्राविधिक सहयोग भइराखेको छ भने काठमाण्डौ महानगरपालिका र ललितपुर उप-नगरपालिकामा निर्माण गरिने ट्रान्सफर स्टेशनहरुमा गर्नु पर्ने वातावरणीय प्रभावको अध्ययन (EIA) पनि Phase IV गरिएको छ । टेकु ट्रान्सफर स्टेशन र सिसडोल ल्याण्डफिल साइटको सञ्चालनको लागि पनि प्राविधिक सहयोग यसै Phase IV बाट November 2005 मा शुरुवात भएको हो र करीव एक बर्षको अवधि रहने छ । बार्षिक कार्ययोजना (AWP) को कार्यान्वयनबाट फोहर व्यवस्थापनको प्रशासनिक पक्ष र प्राविधिक पक्ष दुबै तर्फ क्षमता वृद्धि हुने आशा गरिएको छ । हामी बीचको सहकार्यबाट फोहर मैला व्यवस्थापन कार्ययोजना कार्यान्वयन हुने विश्वास गरेका छौ ।

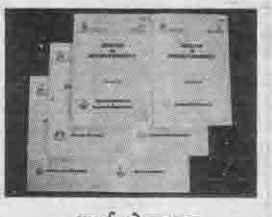
टेकु ट्रान्सफर स्टेशनमा Loading र Unloading अभ्यास

CKV को अन्तिम प्रतिवेदन तयार

CKV अध्ययनका लागि यहांहरुको सहयोग र सहभागिताको लागि धन्यवाद छ । अध्ययनका अन्तिम प्रतिवेदन JICA को मुख्य कार्यालयमा पेश गरिएको थियो र सो प्रतिवेदन पुनः नेपालमा प्रेषित गरिएको छ । प्रतिवेदनमा कार्यकारिणी बिवरण, मुख्य प्रतिवेदन, सहायक प्रतिवेदन प्रथम र द्वितीय साथै प्रत्येक नगरपालिका र फोहर मैला व्यवस्थापन तथा श्रोत परिचालन केन्द्रको कार्ययोजना पनि उद्धृत गरिएको छ । CKV अध्ययनको सिलसिलामा January 2004 देखि सम्पन्न गरिएका कार्यहरुको जानकारी सयौं पृष्ठको यो प्रतिवेदनमा समावेश गरिएको छ । बिभिन्न नमुना योजनाहरुको परिचालनको सिलसिलामा प्राप्त अनुभवको आधारमा यस प्रतिवेदन मार्फत प्रस्तावित कार्ययोजनाले CKV को उद्देश्य *"सफा शहर, हाम्रो रहर"* प्राप्तिमा योगदान पुर्‍याउने छ भन्ने आशा गरेका छौ ।



एक सेट प्रतिवेदनहरु



कार्य योजनाहरु

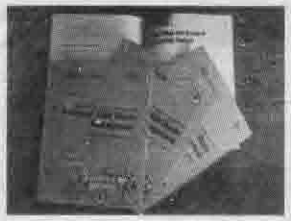
फोहर मैला व्यवस्थापन तथा श्रोत परिचालन केन्द्रका का.वा. महाप्रबन्धकको सन्देश:

सफा काठमाण्डौ उपत्यका (CKV) अध्ययन अन्तर्गत काठमाण्डौ उपत्यकामा फोहर मैला व्यवस्थापनको क्षेत्रमा जापान सरकारको सहयोगले एकीकृत एवं दीर्घकालिन फोहर मैला व्यवस्थापन प्रणालीले एउटा निश्चित दिशा लिएको छ । आफ्ना संस्थाहरुको कार्य योजना तयार गर्न फोहर मैला व्यवस्थापन तथा श्रोत परिचालन केन्द्र तथा नगरपालिकाहरुका सम्बन्धित कर्मचारीहरुको संलग्नता यस अध्ययनको प्रमुख विशेषता हो । प्रत्येक नगरपालिकाका आवश्यकतालाई दृष्टिगत गरी तयार पारिएको यो कार्य योजनाले काठमाण्डौ उपत्यकामा फोहर मैला व्यवस्थापन दिगो रुपमा स्थापित हुन सक्ने छ । CKV अध्ययनको अर्को महत्वपूर्ण पक्ष जापानी बिशेषज्ञहरुबाट अध्ययनकालको दौरानमा गरिएको नमूना योजनाहरुको पहिचान, कार्य योजनाको तयारी र परिचालनको समयमा नेपाली समकक्षिहरुमा गरिएको प्रबिधि हस्तान्तरण पनि हो । अध्ययन कालको दौरानमा नमूना योजनाहरुको पहिचान, कार्य योजनाको तयारी र परिचालन सफा काठमाण्डौ उपत्यका (CKV) अध्ययनको एउटा पक्ष हो । यो सफा काठमाण्डौ उपत्यका (CKV) अध्ययनको एउटा अर्को महत्वपूर्ण पक्ष चाहि जापानी बिशेषज्ञद्वारा नेपाली समकक्षिहरुलाई गरिएको प्रबिधि हस्तान्तरण हो ।

एक बर्षिय अनुगमन र अनुसरण चरणले कार्य योजनाको परिचालनमा नगरपालिकाहरुलाई सघाउ पुर्‍याउनुका साथै कार्य योजनाको परिचालन अवस्थामा आवश्यक प्राविधिक सहयोग पनि प्रदान गर्ने छ भन्ने कुरामा नेपाली पक्ष बिश्वस्त छ ।

काठमाण्डौ उपत्यकामा अवलम्बन गरिएका राम्रा प्रथा तथा अनुभव एउटा राम्रो उदाहरणीय नमूना हुन सक्छ र साथै यी प्रथा र अनुभव नेपालका नगरपालिकाहरुमा फोहरमैला व्यवस्थापनको दिगोपनका लागि अनुकरणीय हुन सक्छ ।

के तपाईलाई काठमाण्डौ उपत्यकामा फोहर मैला व्यवस्थापन सम्बन्धमा हाल भएको जनता र प्राइवेट बीच साझेदारीका बारेमा थाहा छ ?



PPP संचालन हाते पुस्तक

काठमाण्डौ उपत्यकाका पांच नगरपालिकाहरुका क्षेत्र भित्र फोहर मैला व्यवस्थापन सम्बन्धमा प्राइवेट तथा प्राथमिक रुपमा फोहर मैला अन्यत्र थुपार्ने काममा महत्वपूर्ण भूमिका खेलि आएका छन् । उदाहरणका लागि काठमाण्डौं महानगरपालिका भित्र करीब ३५% फोहर मैला उक्त संस्थाहरुले संकलन गर्दै आएका छन् र अन्य नगरपालिकाहरुमा विभिन्न रुपमा जनता र प्राइवेट संस्थाहरुको सहयोग कायम छ । यी संस्थाहरु निजी उद्यमीहरु, गैह्र सरकारी संस्थाहरु र सामुदायिक संस्थाहरु मिलेर बनेको एउटा समूह हो । विविध क्षमता र योग्यता भएका यी संस्थाहरु नगरपालिकाहरु संग सम्बद्ध छन् । सेवा भावनाले अभिप्रेरित केहि गैह्र सरकारी तथा सामुदायिक संस्थाहरुले सामुदायिक गतिविधिहरुद्वारा फोहर मैलाको न्यूनिकरण गर्ने कार्यमा सघाउ पुर्याएका छन् ।

समग्रमा फोहर मैला संकलन तथा ओसार्ने काम सम्बन्धी प्रावधानहरु बारे तुलनात्मक रुपमा प्राइवेट संस्थाहरु र गैह्र सरकारी, सामुदायिक संस्थाहरुका परिचालित नीतिहरु बीच केही भिन्नता छ । फोहर मैला व्यवस्थापनमा प्राइवेट वा गैह्र सरकारी संस्थाहरु को संलग्नता नगरपालिकाका लागि लाभदायी सिद्ध भएको छ र नगरपालिकाको क्षेत्र भित्र संकलन गरिने फोहरमैला बारे पर्ने आर्थिक बोझ घटेको छ । यसै गरि, फोहर मैला संकलन सेवाको बढ्दो संलग्नताले साधारण जनता फोहर मैला व्यवस्थापनको नियमित र भरपर्दो सेवाबाट लाभान्वित हुने देखिन्छ । यस्ता विकास कार्यमा संलग्नताको बावजुत फोहर मैला व्यवस्थापनको क्षेत्रमा (अर्थात नगरपालिकाहरु) र पाइवेट संस्थाहरु (अर्थात प्राइवेट तथा गैह्र सरकारी संस्थाहरु) का समाज सेवीहरुको साझेदारीलाई प्रवर्तत र औपचारिकता प्रदान गर्ने संस्थागत ढांचा र प्रक्रियाहरुलाई कुनै पनि नगरपालिकाहरु मा स्थान दिइएको छैन । फोहर मैला व्यवस्थापन तर्फ जनता र पाइवेट साझेदारीका लागि यस्ता संस्थागत ढांचा र प्रकृयाहरु नगरपालिकाद्वारा अनुशिलन गरी प्राइवेट समाज सेवी, कार्यकर्ताहरुको स्तरीयता बृद्धि गराउनु पर्ने आवश्यकता देखिन्छ । अर्को तर्फ प्राइवेट समाज सेवी, कार्यकर्ताहरुद्वारा गरिने लगानीको सुरक्षा र घाटा न्यून गर्ने तर्फ पनि सोच्नु पर्ने आवश्यकता देखिन्छ । यसका अतिरिक्त, PPP मा स्पष्ट मार्ग निर्देशनहरु पारदर्शी प्रकृयाहरुद्वारा फोहरमैला व्यवस्थापनबाट प्राप्त हुने सेवा जनताका लागि न्यायसंगत ढंगले सुनिश्चित हुने देखिन्छ । अर्को तर्फ, PPP व्यवस्थाद्वारा समाज सेवी, कार्यकर्ताहरु तथा काठमाण्डौं उपत्यका जनता सबै पक्षले सफलता प्राप्त गर्ने वातावरणको सृजना गरिनु पर्छ । माथि उल्लेखित धारणा अनुरुप सफा काठमाण्डौ उपत्यका (CKV) अध्ययनले फोहर मैला व्यवस्थापनका लागि PPP संचालिका पुस्तिका तयार पारेको थियो जसमा हामीलाई आशा छ नगरपालिकालाई प्राइवेट संस्थाहरुसंगको साझेदारीलाई औपचारिकता प्रदान गरी अघि बढ्ने आधार प्राप्त हुनेछ । प्राइवेट संस्थाहरुले यस प्रति सघाउ पुर्याई सकेका छन् ।

वित्त / आर्थिक पक्षको जिम्मेवारी लिएका जाइका अध्ययन टोलीको सन्देश

हरेक सार्वजनिक सेवालाई आवश्यक लागत र सेवाहरु को स्तरसंग तुलना गरि ढांचा र साधन तयार गरिन्छ । खर्च गरिएका मूल्य एउटा महत्वपूर्ण तथ्यांक हो जुन विद्यमान फोहर मैला व्यवस्थापनको अवस्था विश्लेषण गर्न, समस्याहरु पत्ता लगाउन र उचित योजना गर्न । एकै प्रकारले फोहरमैला व्यवस्थापन लागत शिफारिस गरिन्छ (व्यक्तिगत, सञ्चालन र मर्मत र पूंजी), यसलाई छुट्टछुट्टै हिसावले (सडक सफाई, संग्रह, ढुवानी र अन्तिम निष्काशन) वार्षिक रुपमा तथ्यांक राखियोस कि (प्रति टन लागत, प्रति कर्मचारी, प्रति साधन आदि इत्यादी) ।

२१ वटा Secondary Transportation गाडीहरु आइपग्यो ।

Secondary Transportation Vehicles को हस्तान्तरण समारोह

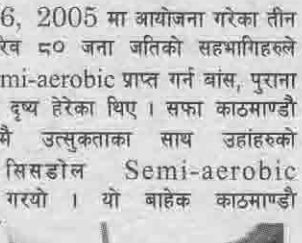
अहिले काठमाण्डौ महानगरपालिका र ललितपुर उप-नगरपालिकामा संकलित फोहरलाई ओखरपौवाको सिसडोल ल्याण्डफिलमा लैजान पर्याप्त ढुवानीको साधन छ । २१ वटा Secondary Transportation गाडीहरु, १८ वटा अतिरिक्त Container र तिनीहरुको जगेडा पार्टपुर्जाहरु Japan Non Grant Aid योजना अनुसार स्थानीय विकास मन्त्रालयले व्यवस्था गरेको हो । यी २१ वटा गाडीहरु मध्ये १७ वटा काठमाण्डौ महानगरपालिका र ४ वटा ललितपुर उप-नगरपालिकालाई वितरण गरिएको छ । यस Secondary Transportation Vehicles को हस्तानतरण समारोह December 21, 2005 मा टेकु ट्रान्सफर स्टेशनमा गरिएको थियो र जापानिज एम्बेसिका राजदूत Mr.T. Hiraoka र जाइका नेपालको आवासीय प्रतिनिधि Mr.S. Yoshiura लाई यस कार्यक्रममा आमन्त्रण गरिएको थियो ।

ढुवानीका नयां साधनहरु (गाडीहरु)

१५ क्यूविक मिटर क्षमताको Container ले प्रति गाडी प्रति ट्रिप ६ टन फोहर ढुवानी गर्न सक्छ । अनुमानित २५० टन फोहर अर्थात ८० देखि ८५ प्रतिशत काठमाण्डौ महानगरपालिका र ललितपुर उप-नगर पालिकामा संकलित फोहरलाई दैनिक दुई ट्रिपका दरले सिसडोल ल्याण्डफिल्डमा ढुवानी गरिने छ र बांकी फोहरलाई हाल भैरहेको विद्यमान गाडीहरुबाट ढुवानी गरि ल्याण्डफिल्डमा लगिने छ ।

Fukuoka तरीकाको कार्यशाला भएको थियो ।

सेमिएरोविक ल्याण्डफिल्डको लागि Professor Matsufuji एकजना योजनाकार हुनुहुन्छ र उहांलाई यसको विकास सम्बन्धि जापान र अरु देशहरुको धेरै अनुभवहरु छन् । Fukuoka University को Professor Matsufuji, र Fokuoka नगरपालिकाको Mr. Sakai ले सेनेटरी ल्याण्डफिल्ड को लागि Fukuoka तरीकाको प्रर्दशनी सिसडोल ल्याण्डफिल्ड साइटमा प्रस्तुत गर्नु भएको थियो र यो क्रियाकलाप UN Habitat र श्री ५ को सरकारले December 6, 2005 मा आयोजना गरेका तीन दिने कार्यशालाको एक क्रियाकलाप थियो । करिब ८० जना जतिको सहभागिहरुले Professor Matsufuji ले कम लागतमा Semi-aerobic प्राप्त गर्न बांस, पुराना टायर र तेलको ड्रम प्रयोग गरेर देखाउनु भएको दृष्य हेरेका थिए । सफा काठमाण्डौ उपत्यका (CKV) अध्ययनले पनि एकदमै उत्सुकताका साथ उहांहरुको महत्वपूर्ण सल्लाह र सुझावहरु सिसडोल Semi-aerobic ल्याडफिलको सञ्चालन सुधार गर्न ग्रहण गरयो । यो बाहेक काठमाण्डौ महानगरपालिका र स्थानीय कमिटिले सहभागिताहरु लाई स्थानीय कमिटिको ल्याण्डफिल सञ्चालन र अनुगमनको सहभागिता बारेमा बताएको थियो । अरु नगरपालिकाहरु बाट सहभागि भएकाहरु उत्साहित भएका थिए यस सजिलो तरिकाबाट ल्याण्डफिल प्रणलीको विकास गर्न र सञ्चालन गर्न र हामी पछि हेर्न चाहन्छौं कि नेपालमा कम खुल्ला ठाउंमा फोहर फ्याकेको र धेरै ल्याण्डफिलको विकास भएको होस ।



Dr. Matsufuji द्वारा स्वलगत व्याख्यान

सफा काठमाण्डौ उपत्यका (CKV) अध्ययनको websit पुन: संचालन हुने ।

अहिले सफा उपत्यका काठमाण्डौ (CKV) अध्ययनको website बिषय वस्तुहरुमा सुधारात्मक छ । यस सफा काठमाण्डौ (CKV) उपत्यकाको नयां website मा अनुगमन र अनुसरण phase को परिचय सहित चाडै नै पुन: संचालन हुने छ ।

Website: http://www.mld.gov.np/swm/ckv/index.html

सफा काठमाण्डौ उपत्यका अध्ययन केन्द्रको कार्यालयमा भ्रमण गरौं
मार्फत : स्थानीय विकास प्रशिक्षण प्रतिष्ठान
पो. व. न. ११९८०, जावलाखेल, ललितपुर, नेपाल ।
फोन नं. ९७७-१-५५५५३७३ (सिधा सम्पर्क)/ ५५२१०५१ (मार्फत: १९)
फ्याक्स: ९७७-१-५५५५३७३
E-mail: nkswms@wlink.com.np